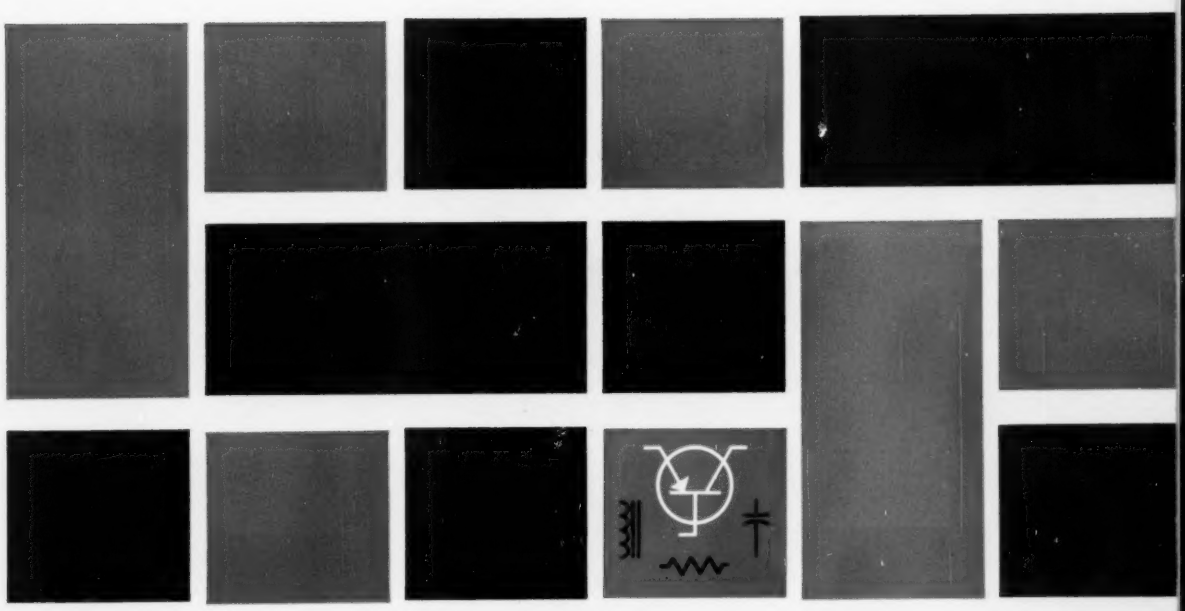
MAY 1, 1958

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Modular Packaging of Transistorized Assemblies

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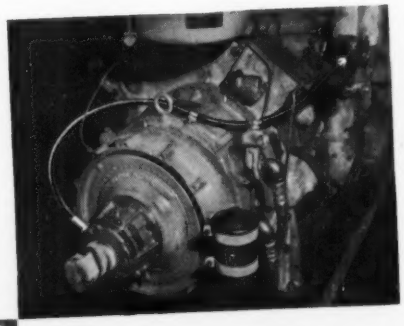
FARNSWORTH

Simplicity in Use – Selecting an S.S.WHITE Flexible Shaft and applying it to any remote control or power-drive application is a quick, easy job. S.S.WHITE has reduced flexible shaft selection to a relatively simple task through the use of standard flexible shaft combinations, clear-cut, quick reference selection tables and expert engineering and technical advice.

Simplicity in Design – Because an S.S.WHITE Flexible Shaft takes power or control around turns and obstacles – eliminates excessive parts – you save space and weight . . . and help improve product efficiency. A typical example is the torque converter governor drive shown. Here the shaft drives the governor from the transmission with a minimum of parts . . . simplifies installation problems, too!

Consider S.S.WHITE Flexible Shafts for driving or controlling parts in your own equipment. We'll be glad to help you work out any application problems you may have. Write, wire or call.



S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

USEFUL DATA on how to select and apply flexible shafts! Write for Bulletin 5601.

S.S.White Industrial Division, Dept. 4, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

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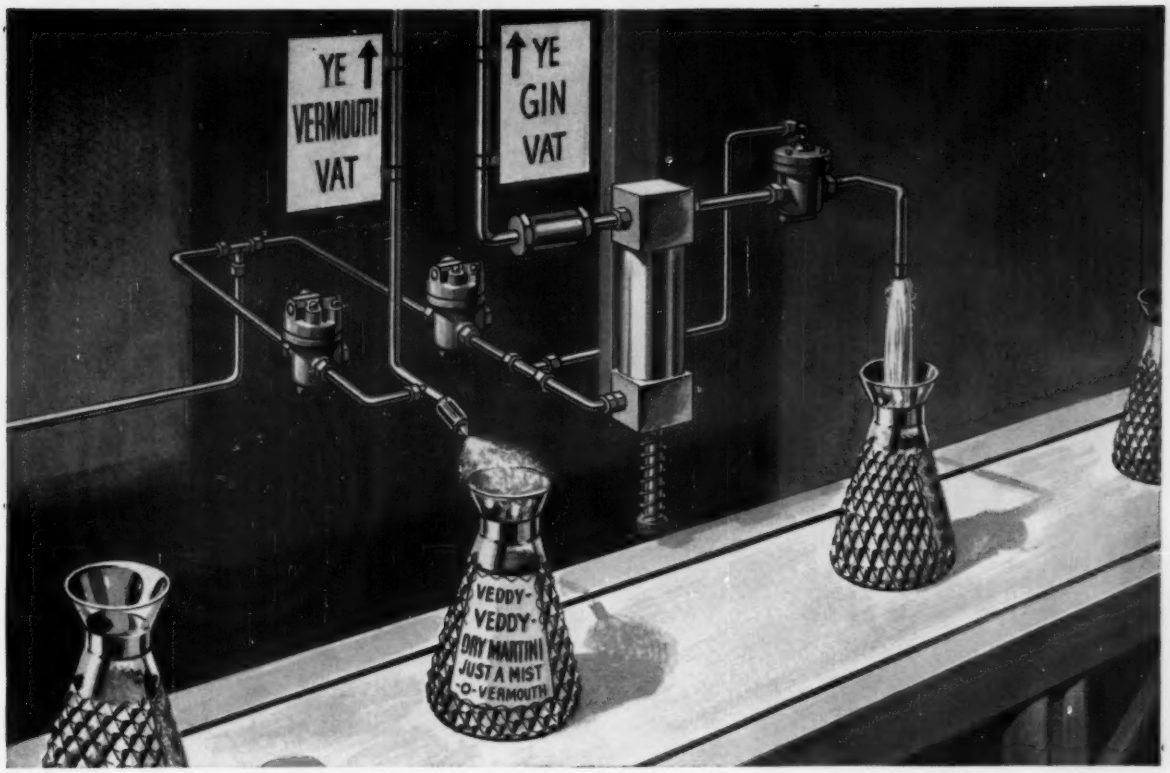


What? Air Automates the Extra, Extra-Dry Martini!

The ready mixed Martini may never come to this but . . .

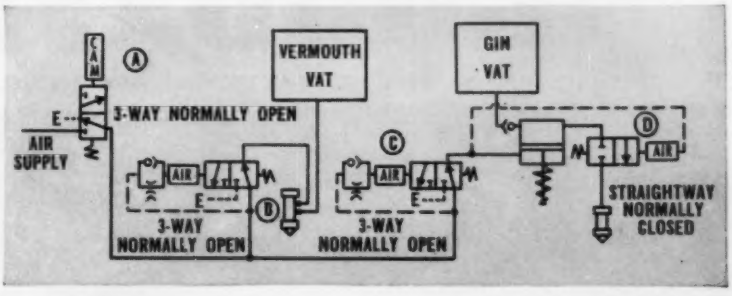
"Don't bruise the Vermouth!" Maybe you subscribe to the idea of only a fog of Vermouth or maybe you like yours four-to-one. But, if it came to bottling this vogue-ish mixture, the circuit here could certainly do it. Meanwhile it gives us a fanciful way to show you how you can easily create an all air circuit that does a continuous sequence of timed operations by using valves that can be both operated and sequenced by air. Every time the conveyor stops, it triggers the circuit.

Triggering one operation with another and timing the operating periods—all with air—may save the day for you.

The same air involved in the main operation can also pilot these valves. What's more these valves can be preset to wait out a time delay before operating, or operate for a self-measured time. Using them you can create unlimited all-air automation systems which could just turn the trick where you wish to avoid electricity, or want to stick with just one power medium.

SEQUENCE OF OPERATION

1. Conveyor indexes, opening cam valve (A). This introduces air to valves (B) and (C) which begin timing out. Vermouth is atomized by Vermouth nozzle, cylinder expels a measured amount of gin through master valve (D) which has been opened by air from the outlet of valve (C).
2. Valves (B) and (C) time out and close, stopping liquid flow.
3. Conveyor indexes again.



ROSS OPERATING VALVE CO. 109 East Golden Gate • Detroit 3, Michigan

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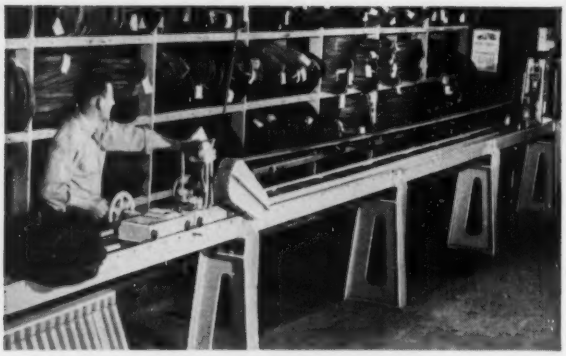
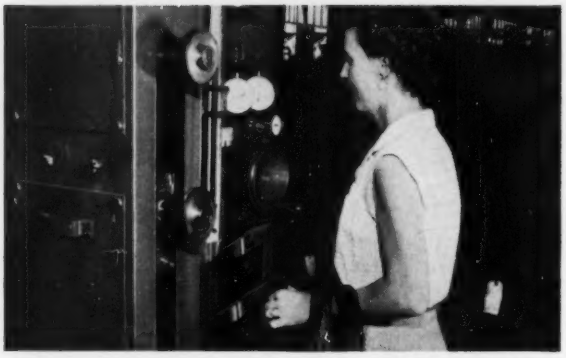
Only V-Belts with the Green Seal give you





Precise measurement of every Goodyear V-Belt and coding to unusually fine tolerances prepare the way for more exact matching of sets—at factory, warehouse, or by distributors. The built-in quality of Dimensional Stability assures that belts stay matched, for life.

dimensional stability – Unsurpassed steel cables or exclusive Triple-Tempered (3-T) Cords provide true dimensional stability from factory to drive.

– that assures you of –

matched sets that stay matched – Sets of belts are matched to the closest standards. And they stay matched under all conditions of storage.

minimum stretch on the drives – Belts on multiple drives work as a team. You eliminate "loafers" – or overworking any of the belts.

– and you also get –

high modulus – You get the greatest possible resistance to shock-loads. You're protected from power loss due to "creep."

friction balance – Covers have the ideal coefficient of friction. No sticking or grabbing in the grooves. And no dusting.

mildew immunity – You're safe from the effects of moisture – in use or in storage. Stand-by belts are always ready for use – no matter how long you keep them.

– and all that pays off in –

–maximum, trouble-free horsepower hours–at minimum cost – on any and every drive in your plant. It's easy to see why you should see your Goodyear Distributor for details. Or write to Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

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GOODYEAR

60 YEARS

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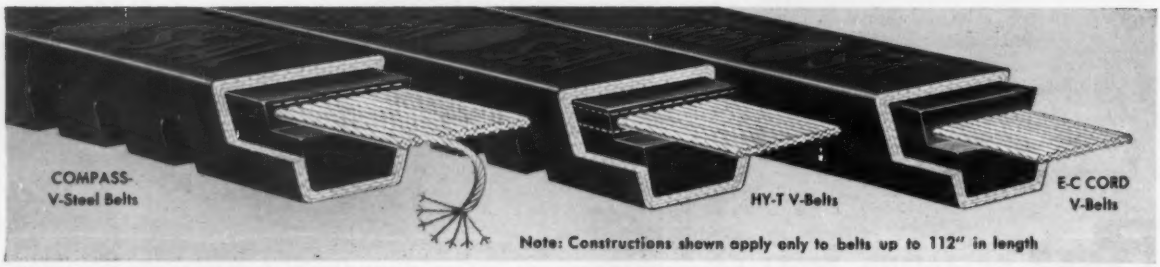
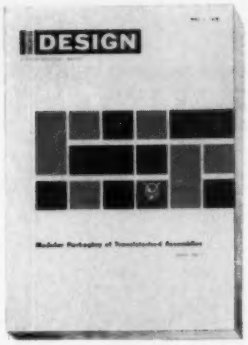


Note: Constructions shown apply only to belts up to 112" in length

Watch "Goodyear Theater" on TV—every other Monday, 9:30 P. M., E. D. T.

Compass, E-C Cord, Hy-T, Green Seal–T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio



Front Cover: A simple pattern of black, gray and red rectangles is used by artist George Farnsworth to represent the module concept in packaging transistorized circuits. Article by A. A. Lawson and J. D. Svedlow is on Page 114.

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MACHINE DESIGN

May 1, 1958

Volume 30—No. 9

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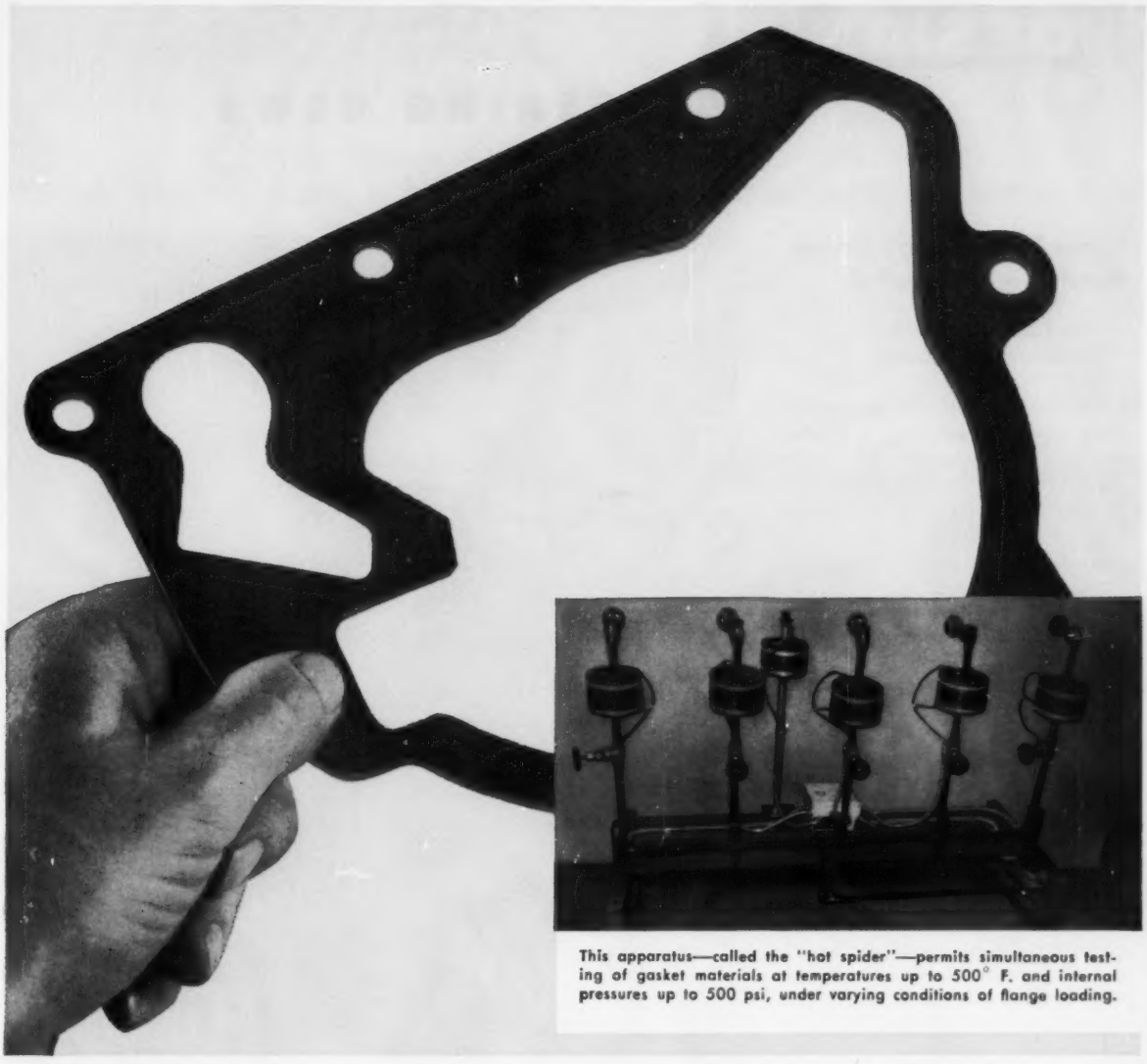


This apparatus—called the "hot spider"—permits simultaneous testing of gasket materials at temperatures up to 500° F. and internal pressures up to 500 psi, under varying conditions of flange loading.

Accopac gaskets seal perfectly at high temperatures in heavy-duty applications

In many heavy-duty applications, the combined effects of elevated temperature and high internal pressure often cause leakage at gasketed joints.

To meet these difficult sealing requirements, new Armstrong Accopac gasket materials have been developed. They seal perfectly under combinations of heat and pressure that can cause extrusion and excessive bolt-torque loss with conventional materials.

The new Accopac materials are pre-compressed, high-density sheets made by a beater-saturation process pioneered and patented by Armstrong. Sheets made in this way are tough, flexible, and crush resistant.

These Accopac compounds are recommended for a wide range of heavy-duty applications. Where temperatures above 300° F. are involved, Accopac asbestos-fiber sheets are recommended. For temperatures up to 300° F., new cellulose-fiber stocks are available.

The new compositions can be used as economical replacements for conventional sheet asbestos or other more expensive materials. In many cases, the Accopac materials make possible substantial savings.

Armstrong Accopac is available in rolls, sheets, ribbons, and die-cut parts. For more information about these versatile new compositions, write for a copy of our new Accopac folder. Address Armstrong Cork Co., Industrial Division, 7005 Dean St., Lancaster, Penna.

Armstrong ACCOPAC

. . . used wherever performance counts

Circle 406 on Page 19

Double-Barrel Aircraft Cannon Mounted in Portable Pod

New Gun Marks Trend To External Armament

EL CENTRO, CALIF. — An underwing gun pod carrying a double-barrel 20-mm cannon with eight times the firing rate of World War II models will soon be an optional accessory on Naval aircraft. The pod can be attached to a plane in a matter of seconds, by two simple connections, and can be instantly jettisoned in flight. Designated Mark 11 it was developed by Navy Bureau of Ordnance and the Aircraft Div. of Hughes Tool Co.

According to Navy officials, the gun pod further increases aircraft versatility by adding cannon to weapons already carried externally —rockets, missiles, and bombs. This gives commanders a weapons option, depending on tactical situation, which is impossible with built-in armament. As an additional advantage, any plane capable of lifting an 1100-lb load can be converted, in emergency, into a gun-firing tactical aircraft.

The pod idea is not new, but was impractical until recent development of compact high-rate guns. The Mark 11 apparently fits container requirements to perfection by providing high fire-power in a compact mechanism with small frontal area, reducing aerodynamic drag to a minimum. Navy expects the weapon to become operational in 1959.

Despite attention on more radical weapon concepts, fast-firing guns are extremely important tactical weapons. Navy's new double-barrel aircraft cannon helps fill the need—fires 4000 rounds per minute. Carried in a detachable aerodynamic pod, it can be wing-mounted on variety of aircraft.

Outer Space Travel Demands More Reliability, Says Expert

DOWNEY, CALIF.—The U. S. has the capability of doing a number of satellite and moon missions with present equipments and modest developments, says an authority on astronautics, but interplanetary missions should be based on new systems yet to be constructed. The reliability of present-day equipment must be improved from 100 to 10,000 times, according to Dr. Robert E. Roberson, of Autonetics, a division of North American Aviation.

Using a one-way 6000-hour trip to Mars as an example, Roberson said, "To keep the failure probability on such a trip down to one per cent, the average time such a mission's system has to work without failing is 600,000 hours, or about 68 years." This would permit 99 out of 100 ships launched for Mars to reach their destination. Dr. Roberson made no further mention of the 100th ship.

Please direct inquiries to advertiser, mentioning MACHINE DESIGN→

. . . Fluid Power news

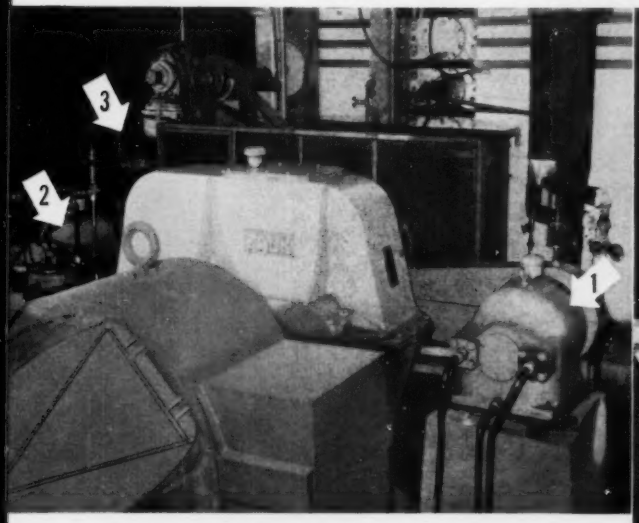
REPORT NO. 12,102
"ANY-SPEED" WINDER DRIVE CUTS COSTS

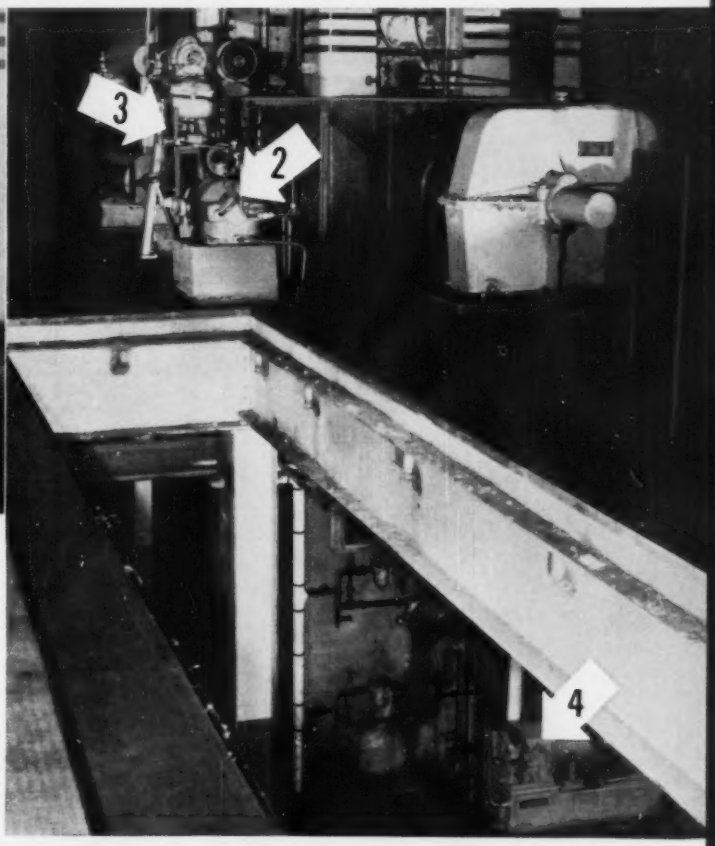
From Oilgear Application-Engineering Files

HOW OILGEAR "ANY-SPEED" WINDER DRIVE IMPROVED SUPER CALENDER PERFORMANCE AND PRODUCT QUALITY

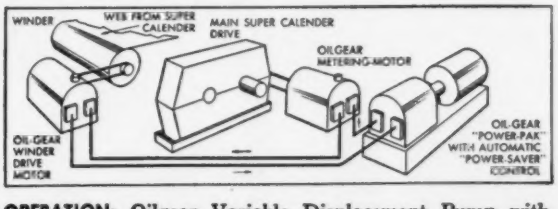
CUSTOMER: *A Large Midwestern Paper Manufacturer*

DATA: This company had the same problem on a super calender that faces every manufacturer of a continuous sheet, strip or web that can be easily torn or broken . . . winder synchronization and tension control for top product and roll quality. *Specific job requirements*: 1: Use minimum of calender main electric drive power to prevent possibilty of overload. 2: Close tolerance "Any-Speed" synchronization between winder and calender to prevent loose winding at low speeds, "catch-up" and tearing at high speeds. 3: A minimum top operating speed of 1,000 ft/minute. 4: Dependable, trouble-free, round-the-clock performance. 5: Conserve valuable floor space. This application is a particular challenge, since other drive which provided a high top speed proved uncontrollable on starting take-off.





SOLUTION: An Application-Engineered Oilgear "Any-Speed" Winder Drive System . . . an Oilgear heavy-duty "Power-Pak"; two series-connected, constant torque, fixed stroke, Oilgear Fluid Power motors; an Oilgear automatic, adjustable, winder tension valve. This installation easily surpassed all specified requirements, and has operated on a continuous 24-hour schedule for over 3 years with no reported major maintenance. User Reports — *this winder drive has assured consistent production of high-grade finishes, good roll quality, and reduced over-all cost of machine operation.* Due to constant, "Any-Speed" synchronization, and unvarying tension on the paper web in the super calender stacks, "break-fold" marks on soft calender rolls have been virtually eliminated — resulting in longer calender roll life. Costly roll refinishing and machine downtime are sharply reduced.



OPERATION: Oilgear Variable Displacement Pump with Automatic "Power-Saver" Control (4) supplies Fluid Power to metering-motor (1) — "tied" to main super calender drive. In this way, metering-motor (1) tends to boost main calender drive power rather than taking power from it. Starting a new roll, series-connected winder-motor (2) must run at high speed, requiring high volume at low torque (pressure). As roll diameter increases, proper web tension is maintained over a wide core-to-full-roll ratio by automatically increasing torque (pressure), and decreasing volume. Automatic web tension control is fully adjustable.

Photo upper left shows Oilgear metering-motor (1) to right, as connected with main calender drive. Winder-drive motor (2) and back panel for automatic, adjustable, winder-tension control (3) can be seen in background. Photo above shows Oilgear heavy-duty "Power-Pak" (4) installed in basement beneath super calender to conserve valuable floor space. Also shown are Oilgear winder-drive motor (2), and automatic, adjustable, winder-tension control panel (3).

Whether you need constant or automatic tapering tension, constant or automatic tapering torque, or a combination of torque-tension characteristics . . . there's a dependable, Oilgear "Any-Speed" drive to meet your requirements.

Users in every industry claim — "for lowest-cost-per-year . . . it's Oilgear!"

For similar practical solutions to YOUR linear or rotary drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

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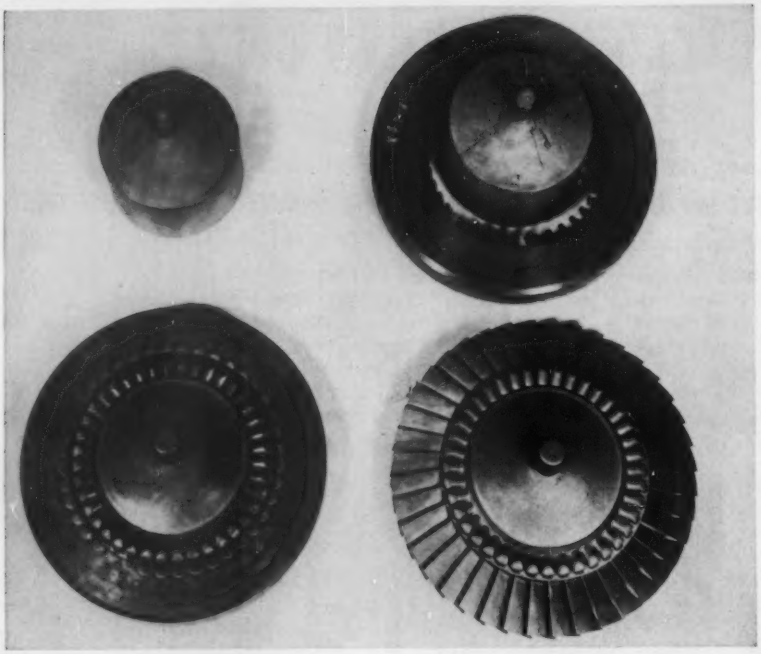
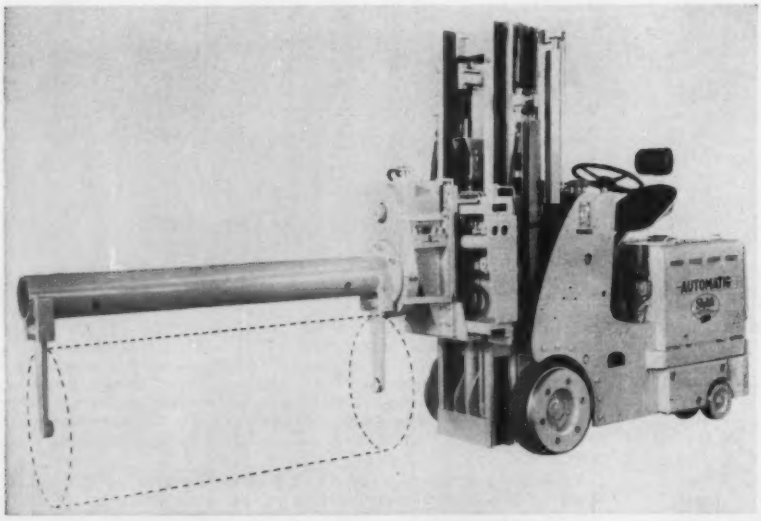


NO BROACHING is required to produce turbine and compressor rotors in a new cost-saving process developed by Ford Motor Co.'s engineering research staff. Former methods involved close-tolerance machining of both turbine blade roots and blade cavities. In Ford's process, blades are positioned by an outside ring and inner die. When properly aligned and indexed, space between blades is filled with Kirksite (melts at 700 F) which is allowed to solidify. Inner die is then removed, hot billet is substituted, and a heavy forging press extrudes billet over, under, and around the blade roots. Excess metal is removed from turbine faces by relatively minor machining, and wheel is complete. Four stages, above begin with billet, upper left; end with finished rotor, lower right.



BOTH RAILS AND ROADS are thoroughfares for this truck built by Automatic Transportation Co., Chicago, for transport and tiering of mill rolls of cellophane, paper, textiles, and the like. For stability in these operations, flanged wheels, fitted outboard the conventional type, run on rails sunk in warehouse floors. The truck lifts 1500-lb rolls 74 in. long, 24 in. in diameter, to heights of 146 in. Load supported by ram can be shifted 14 in. and turned 90 deg either side of truck center.

Topics

A corking good substitute for the traditional bottle stopper, the plastic plug is gaining in favor because of its lower cost. Over 70 per cent of California champagnes are now "corked" with plastic, which costs about half as much as cork.

• • •

Supersonic service from the Post Office would be made possible with rockets carrying mail through a transcontinental tube. Practicableness of such a system is being studied by Aerojet-General Corp., California rocket builder.

• • •

Rockets may also carry nourishment to isolated people. Members of the German Association for Rocket Techniques are working on a project to provide North Sea islanders with food by means of rockets.

• • •

Instant words: Just add water on the end of a pen or stylus, write on a newly patented paper, and the writing appears in a dark color simulating ink. The paper is treated with two layers of water-soluble chemicals that react with each other upon the application of water.

• • •

Where there's smoke, there can be printing, with an apparatus that deposits electrically charged particles on paper without application of pressure. Smoke printing machine, developed by William C. Huebner, uses smoke, chemicals, misted colors, vapors or gases. The electrically charged cloud is released from a nozzle near the paper or other material on which the printing is to be done. Original copy may be transparent or opaque. Light penetrating it or reflected from it causes particles to adhere in a reproduction of the original type or picture. Either positive or negative prints can be made.

• • •

Wall-to-wall heat is produced by a British-made carpet that is claimed a replacement for central heating in mild climates. Thermalay has heating elements sandwiched between layers of felt. It plugs into an electric outlet to provide a floor temperature of 70 to 75 F.

• • •

Not-so-whirly bird, a plane being developed by Piasecki has neither wings nor external rotary blades. Rotors are housed within the chassis of the aircraft, which would permit flying between buildings and other obstacles. Take-off is vertical.

Circle 407 on Page 19→

NEWS ITEM No. 5

NEW FM IRON

Any association with FM Radio is strictly coincidental ...
BUT WE ARE BROADCASTING OUR NEW FREE MACHINING POWDIRON AS THE ONLY 100% SINTERED IRON THAT CAN BE MACHINED SUCCESSFULLY ... EXCELLENT FOR BEARINGS AND PARTS ...

PHOTOS UNRETOUCHED

ORDINARY SINTERED IRON

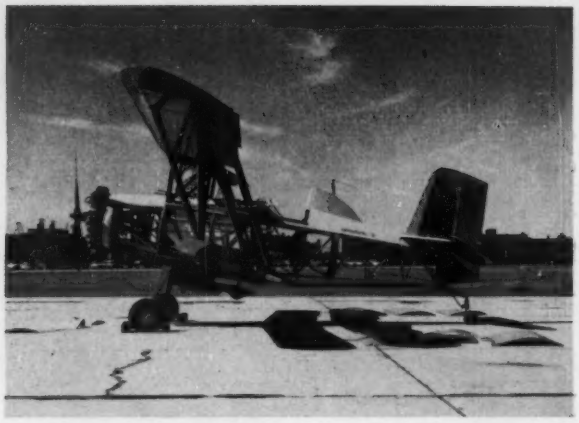
POWDIRON FM

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in
POWDER METALLURGY BEARINGS & PARTS

our 75TH year



NEW AND SUBSONIC, Grumman's Ag-Cat biplane is designed specifically for low-altitude pest fighting—crop dusting and spraying. Top speed of the maneuverable farm aid is 110 mph; stall-speed, 42 mph. It can make a continuous 1.5-g turn at dusting speed and at maximum gross weight (3600 lb). Unique design features include interchangeable upper and lower wings and simple maintenance accessibility to internal structures. Power plant is optional—can be selected from any of a half-dozen new or used engines available in the 200 to 300-hp class. Hopper capacity is 1000 lb or 217 gal; take-off distance, loaded, is 675 ft.

Amplifying Device Uses Semiconductor and Electrolyte

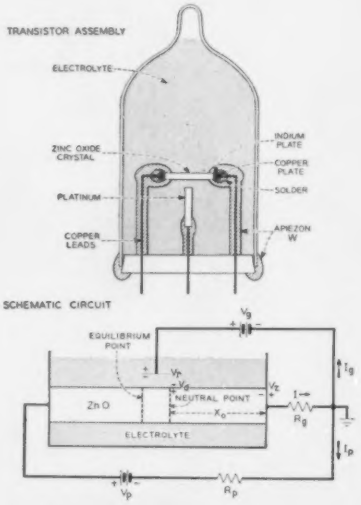
Laboratory Tests Show Gain of 15 db at 1000 cps

NEW YORK—A new concept in amplifiers, making use of the transistor action at the interface of a semiconductor and an electrolyte, was described recently by a Bell Telephone Laboratories scientist. He reported laboratory experiments have demonstrated amplifier operation at 1000 cps with a gain in excess of 15 db.

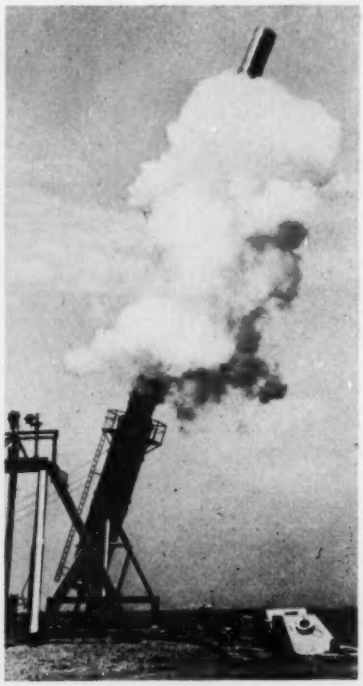
The experimental device described by J. F. Dewald uses a hexagonal, rod-like crystal of very pure zinc oxide as the semiconductor, immersed in a highly conducting electrolyte. A platinum electrode placed nearby serves as the grid element. Because zinc oxide is a large-energy-gap semiconductor, it can be operated in a high enrichment condition, with one end of the crystal biased as a cathode with respect to the solution, and the other end biased as an anode.

Between cathode and anode is a neutral point which is unbiased and where the energy bands are flat right up to the surface of the crystal. As this neutral point shifts back and forth under the influence of varying, biasing grid voltages, the resistance of the crystal changes, passing a current which very closely follows the driving frequency. A fairly extended range of linear response is obtained.

Small size is required to give high-frequency operation. The smallest units constructed so far use crystals about 0.3 mm long and 0.15 mm in "diameter."



Cross section and circuit show operating principle of electrolyte-transistor amplifier. To make electrical contact to the zinc-oxide crystal, the two ends are first indium-plated to assure good contact, then copper-plated to allow soldering copper wire leads. Platinum grid completes the assembly. After insulating all wires except the grid, the assembly is immersed in the electrolyte and hermetically sealed in a glass tube.



POLARIS LAUNCHER being developed by Westinghouse is pictured here as it ejects a dummy redwood missile. Method used is one of several techniques being evaluated and is similar to the launching of aircraft from Navy carriers. Underwater tests using simulated missiles the same size, shape, and weight of the 1500-mi range weapon are also in progress. According to prime contractor Lockheed Aircraft Corp., Polaris is the only U. S. ballistic missile now ahead of development schedule.

ND FACTS

PHOTO COURTESY OF THE OLIVER CORPORATION, CHICAGO, ILLINOIS

THESE LIGHT-DUTY DISC BALL BEARINGS NEED NO SERVICE!

That's right! There's no "downtime" for relubrication or other periodic attention!

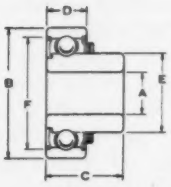
These New Departure Disc Bearings are efficiently sealed to shut out dust, dirt, moisture and *wear*. Deep-grooved races give *extra stability* where misaligning loads occur. Their machined bores fit standard-size machine bolts to give you economical, simplified mounting.

Count on New Departure, as do other leading farm implement manufacturers, to help you add *sales appeal* and *design simplicity* to your products.

Left, a Type I bearing in single-mounted grain drill disc. Recommended where extremely contaminated conditions require extra sealing precautions.

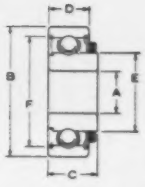
Left, a Type II Light-Duty Disc Bearing mounted in double-disc furrow opener, uses standard ⅝" machine bolt.

PRINCIPAL DIMENSIONS



TYPE I

Type	Bearing	Bore A	O.D. B +.0000 −.0005	Inner Ring Width C ±.005	Outer Ring Width D ±.005	Inner Ring Outside Dia. E	Outer Ring Inside Dia. F
I	87504A16	.632 .626	1.8504	1.125	.5512	1.1585 1.1575	1.634
II	87504U	.632 .626	1.8504	.686	.5512	1.1585 1.1575	1.634



TYPE II

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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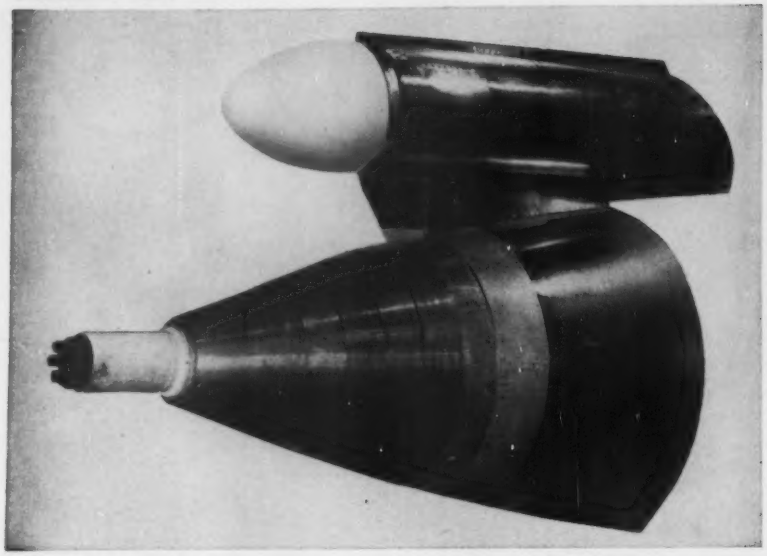
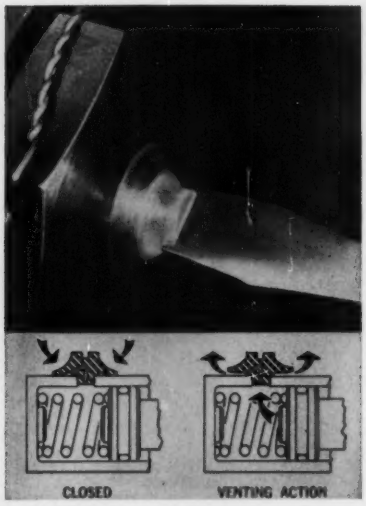


TELESCOPING TAIL TURRET for the B-58 is patterned after the old collapsible metal drinking cup. The unique design provides a good sweep of the sky without disturbing airflow at supersonic speeds. Turret houses a six-barrel, 20-mm version of the Civil War Gatling gun. The weapon can fire 5000 one-lb shells per min which poses a problem in ammunition conservation. This is effectively solved by a highly sensitive radar aiming device, above turret, which seeks out target and fires the gun in controlled bursts. Turret and radar system were developed by Electronics and Avionics Div., Emerson Electric Co., St. Louis.



NO CHANCE contaminants or moisture can enter through this tiny seal, which uses an entirely new venting principle. The thumbnail-sized valve, made from Kel-F, plays a big role in Rocketdyne liquid-rocket - engine components; is thought applicable to the manufacture of relief, check, safety, and breather valves.

FOUR-PLACE ISETTA, new for 1958, has twice as much power and one more door than the familiar two-seater. Called the "600", its two-cylinder, horizontally-opposed, air-cooled engine develops 26 hp at 4500 rpm; has a compression ratio of 6.8 to 1. By comparison, the two-seater (model "300") has a one-cylinder powerplant rated at 13 hp. Side door has been added to the "600" for rear-passenger accessibility; driver and partner board via front door as usual. Difference between front and rear track has been reduced from 26.6 in. on the "300" to about 3.5 in. on the new "600." Top speed of the "600"—68 mph. Fuel consumption, under normal conditions—an estimated 58 mpg. Synchromesh transmission provides four forward speeds plus reverse. Chassis-frame is welded tubular steel.

Medical Examination by Radio Can Monitor Health of Spacemen

WASHINGTON—A method of converting physiological data to electrical equivalents, for transmittal by radio and telephone is a recent development of the Naval Medical Research Institute.

The new system works by measuring impulses generated in the body and by converting other functions such as body temperature and respiratory volume into electrical equivalents. This electrical phenomenon, taken from the body by special electrodes, is amplified as required and caused to modulate an oscillator or radio transmitter. The impulses are then transmitted over radio or telephone to the receiving station where the signal is converted back to the original form. It is portrayed on oscilloscopes, direct writers, and audio systems and recorded on magnetic tape to provide a permanent record.

The achievement will permit doctors in isolated or remote areas to forward their patients' heart murmurs and blood pressures to a large-city clinic for specialized diagnosis.

TORRINGTON SPHERICAL ROLLER BEARINGS

The Manitowoc 4500 Power Shovel is equipped with Torrington Spherical Roller Bearings in 7 critical heavy-duty, high-speed applications where they eliminate stress concentrations and provide long service life.

How to get a big lift

Torrington Spherical Roller Bearings in critical positions on the Manitowoc shovel help it handle tons of earth and rock with ease and speed!

Accurate roller-to-race conformity and positive roller guidance of Torrington Spherical Roller Bearings insure long, trouble-free service. They are used on the swingshaft, PTO sprocket support, front drum main shaft, front and rear drums, countershaft, PTO pilot and vertical travelshaft. These self-aligning bearings insure smooth anti-friction operation and efficient transmission of power despite heavy radial and thrust loads, housing misalignment and shaft deflection.

Wherever heavy-duty construction equipment is at work, Torrington Bearings are contributing to efficiency and long service life. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

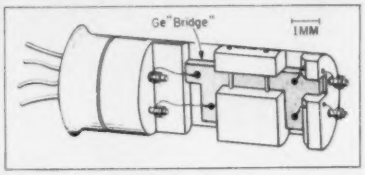
Circle 409 on Page 19

TWO-PLACE F106B, new version of Convair's F106A interceptor, is shown in this recently released photograph shortly before flight tests. Except for the F106B's tandem second seat and longer cockpit canopy, the two versions look alike. Both are big planes—more than 70 ft long—powered by Pratt & Whitney J-75 engines. Both carry Falcon guided missiles and advanced automatic Hughes armament systems. Air Force has been evaluating the F106A since early 1957; has released no performance data except that the plane flies "higher and faster" than any other all-weather interceptor.

Tiny Resistance Thermometer Made of Germanium Crystal

NEW YORK—Shorter than a common straight pin is this germanium resistance thermometer. Yet is gives readings reproducible to better than a few ten-thousandths of a degree at helium's boiling point (4.2 K).

Developed at the Bell Telephone Laboratories, the thermometer contains a very small "bridge" cut from a single crystal of arsenic-doped germanium. The bridge is supported in a platinum-glass enclosure filled with helium gas to aid thermal conduction. Resistance is determined by measuring the potential drop when a small known cur-



Atom Angles

X-8001, a recently developed aluminum alloy is expected to help reduce the cost of producing nuclear power. Developed at the Argonne National Laboratory, the alloy is used as a protective jacket (cladding) for fuel elements in nuclear reactors. Small amounts of nickel were added to aluminum 1100, a commercial alloy which contains iron. The addition of nickel made the new alloy much more resistant to corrosion by high temperature water than commercial aluminums having iron as the primary alloy material.

• • •

Competitive nuclear power is less than two years away, predicts John E. Ullmann of the Department of Industrial and Management Engineering at Columbia. He bases his forecast on a comparative analysis of cost trends. Conventional steam power plants, he says, will have ever-increasing difficulty in producing electricity at present cost levels, but plants using some form of atomic energy as fuel will be able to produce power at steadily decreasing costs.

He notes "a break-even point" where the upward cost trend of conventional power meets the downward trend in nuclear power costs, but says this will not last long. His method of comparison, he says, "points to an early and sharp cost distinction favoring nuclear power."

• • •

Conversion to nuclear power of a tanker now under construction will be undertaken by George G. Sharp Inc. as the ship design agent and General Electric Co. as the reactor designer in accordance with contracts recently awarded by the AEC and the Maritime Administration. The tanker, now under construction, is a 22,500 deadweight ton prototype, designed for a normal speed of 20 knots at 20,000 shp. Contract terms call for preliminary engineering and design studies to be completed in about three months.

• • •

Nuclear fusion reaction has been attained by the Japanese, says a recent report from Osaka University. Temperatures well above 1 million C, for one microsecond duration, were attained with the number of neutrons emitted estimated at 5 million. This compares with 3 million neutrons per pulse previously reported by the British in experiments with their Zeta apparatus. Dr. Okada, of the University's faculty, reports the Japanese apparatus should eventually produce a temperature of 5 million C.

Airborne nuclear reactor for the Air Force will be suspended from four 300-ft towers for atomic radiation testing. Designed and built by Convair Div. of General Dynamics Corp., the world's first airborne reactor has been carried on 47 experimental flights aboard a modified but conventionally powered B-36 bomber. At the AEC's facility at Oak Ridge, the reactor will be suspended from the four towers for a joint AEC-Air Force study of radiation patterns. The information will be used in design of compartments to protect crews of nuclear-powered airplanes.

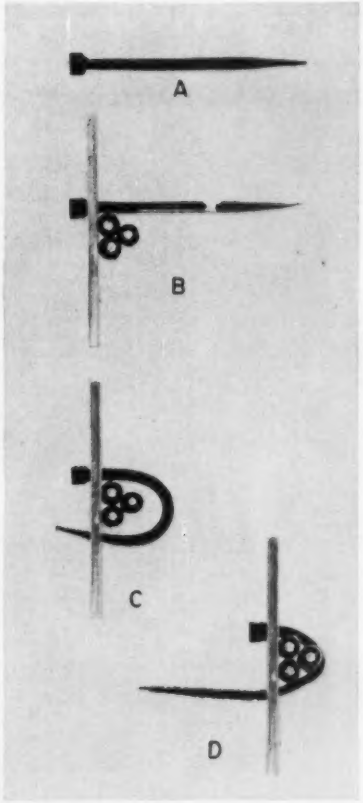
• • •

Sharp price reductions for five long-lived radioisotopes have been put into effect by the Atomic Energy Commission. Generally, the new prices are less than 10 per cent of those formerly in effect. Reductions apply for cesium 137, promethium 147, cerium 144, strontium 90, and technetium 99.

The reductions, expected to encourage greater use of radioisotopes in industrial and research applications, are based on estimated production from the new Multicurie Fission Product Pilot Plant at Oak Ridge. Scheduled for operation in the summer, the pilot plant will recover usable byproducts of the fission process on a larger scale than previous laboratory facilities permitted.

rent is passed through the bridge.

Germanium can be doped with arsenic to produce a high and fairly constant temperature coefficient of resistance at temperatures near the boiling point of helium. For example, one typical thermometer had a resistance of about 1 ohm at room temperature, 14 ohms at 10 K, and 216 ohms at 2 K. Both the temperature coefficient and the actual resistance vary widely with minute changes in the amount of doping, making it possible to fabricate a thermometer having any of a wide range of characteristics. Such a thermometer, reportedly, will retain its calibration despite repeated cycling from 300 K to 1 K.



MOUSE TAILS, developed by Boeing Airplane Co., secure wire bundles to chassis in compact electronic packages used in the Bomarc interceptor missile. Original Mousetail at *a* is inserted through a hole in the chassis at *b*, looped over the wire bundle and inserted in adjacent hole as in *c*, and pulled tight in *d*. Upon release of tension, the rubber expands to fill the hole and secure the bundle. Finally, its end is clipped off flush with the chassis.

DRAFTING TRENDS

This Gray Scale Film for rating print quality is included in POST'S new, free Print Evaluation Kit. Among other materials in the Kit is a handy Checklist highlighting important factors to look for in your prints.

New Evaluation Kit shows that many factors determine print quality

Progress in the technology of printmaking in recent years has been tremendous. Despite outstanding developments in reproduction equipment and in print papers and cloths, the yardstick to decide acceptability of a print still remains the same—its *readability*

Since print appearance is so vital in properly transmitting design ideas to plant, field and customers, it is increasingly important to be familiar with all factors that contribute to print readability.

A newly-developed Print Evaluation Kit is now available that goes a long way to help appraise print quality. As coater of a broad range of blueprint and diazotype papers, Frederick Post Company originally developed a number of the materials in this Kit for its own Laboratory use, in order to check its own papers against competitive products.

Materials for rating print quality

The Kit includes various materials useful in helping to rate print quality: an evaluation chart (gray scale film), a rating device and a checklist that reviews a variety of factors, such as image color, stability of line and background, keeping qualities, etc. Several "check points," useful to machine operators in analyzing troublesome print characteristics, are included.

Your Kit will be tailored to your needs

Send today for further information on this free Kit. Variations of this kit are available to suit your print making equipment whether it is an ammonia process or semi-moist machine, whether you favor bluelines, black on white or blueprints.

Write Reader Service Division of Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18, Ill.

POST

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ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

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Friendly inferno— to make BETTER GEARS

THIS 100% forced convection furnace is just one unit of the highly specialized equipment used in making "Double Diamond" gears. Because we manufacture gears—and only gears—we avail ourselves of every kind of improved technique and equipment that will produce completely controlled quality.

What does this mean to you? Simply this:

BETTER GEARS that offer the advantages of lower installed cost, economical and dependable service on the job for which you buy them . . . gears that do credit to your product and your reputation.

Our gear engineers are available for consultation. Just write.

In this controlled atmosphere furnace, 100% forced convection heating of gears by Automotive Gear Division insures uniform heating of every part to the desired temperature. Through the entire operation—pre-heating, carburizing, hardening and modified Marquenching or regular quenching in selected grades of oil—time, temperature and atmosphere in each zone are automatically controlled. Thus, the quality that is cut into the gear is retained.

EATON

AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

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for More Information . . .

CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carriers an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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418	443	468	493	518	543	568	593	618	643	668	693	718	743	768
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422	447	472	497	522	547	572	597	622	647	672	697	722	747	772
423	448	473	498	523	548	573	598	623	648	673	698	723	748	773
424	449	474	499	524	549	574	599	624	649	674	699	724	749	774
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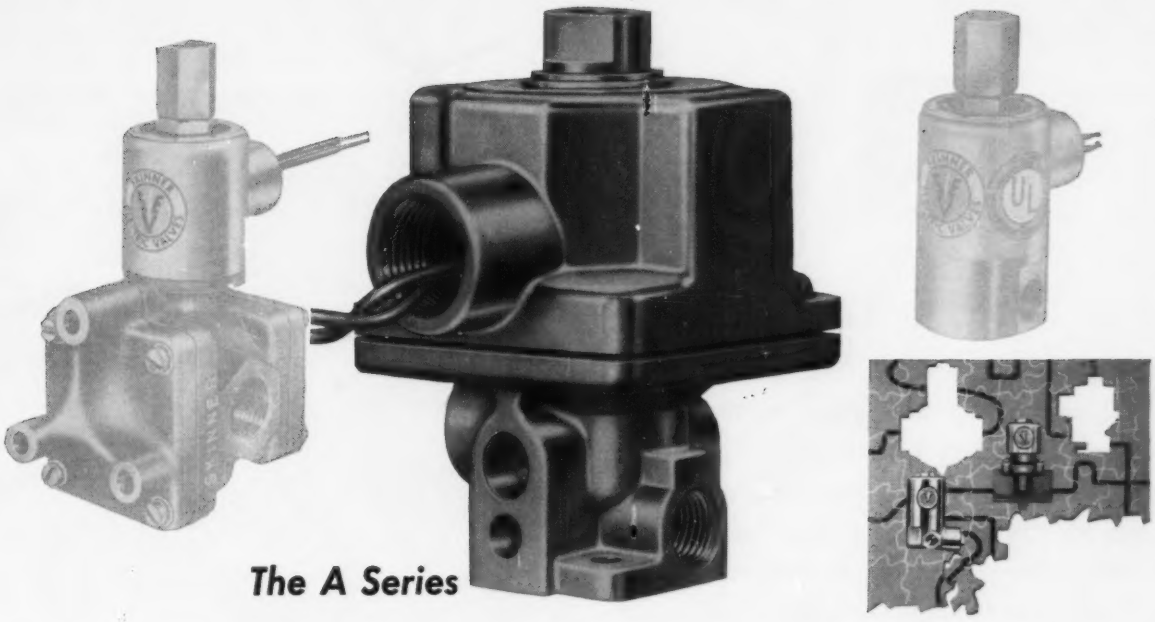


The A Series

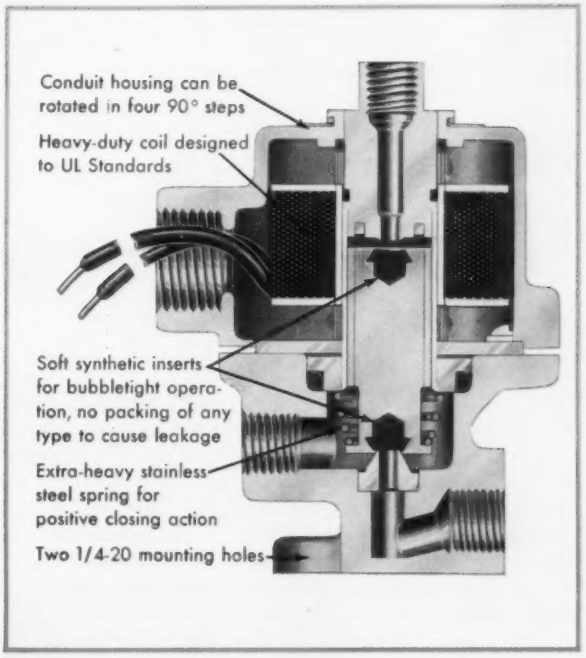
NEW— three-way Skinner Valve line for medium-size cylinders

This new A Series valve line bridges the gap between the famous V5 line used with small cylinders and the reliable M3 line used with large cylinders. The design of this new line permits economical and efficient operation of medium-size cylinders as well as faster operation of smaller cylinders where increased cycling speed is a necessity.

The first of the A Series line is a 3-way normally closed valve with a $\frac{5}{32}$" orifice and $\frac{1}{4}$" NPT ports, and a pressure rating of 125 PSI. It is designed for use with such media as oil, air and inert gases.

Despite the increase in capacity, this new valve is light in weight (only 3 pounds) and compact ($3\frac{7}{8}$" high and $2\frac{5}{8}$" square). The body and mounting are non-corrosive zinc and the internal parts are stainless steel. The plunger is spring-loaded and direct-acting, and the valve can be mounted in any position. Soft synthetic inserts are used, assuring bubbletight operation and long, trouble-free life.

For additional information, options and specifications, call the Skinner Representative or Distributor nearest you – he's listed in the Yellow Pages. Or write us at the address below, Dept. 425.


Conduit housing can be rotated in four 90° steps
Heavy-duty coil designed to UL Standards
Soft synthetic inserts for bubbletight operation, no packing of any type to cause leakage
Extra-heavy stainless steel spring for positive closing action
Two 1/4-20 mounting holes

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

Long ago, sickle, scythe, and scissors displaced sheep and goats as the means of keeping lawns trimmed. Today, power is added to machines that employ the principles of those hand tools. A growing variety of these machines indicates the task their designers have to fill correspondingly varied customer requirements. Recent additions and the nature of long-standing types are summarized in this survey of . . .

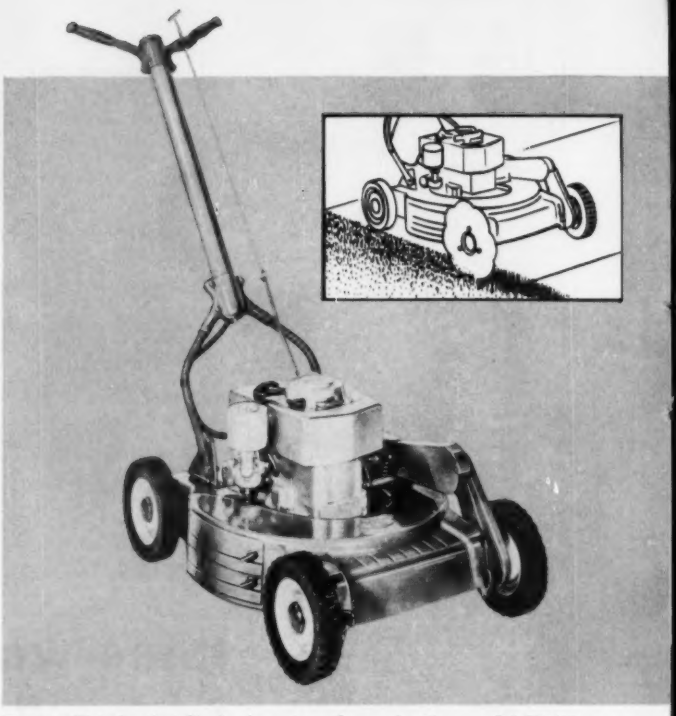


Fig. 1—Tubular handle is the gas tank on the Reo model TS421 Power-Trim. Stooping to fill is unnecessary, for gas cap is at the handle-bar end. At same location is single-knob motor control. Knob turns to start, run, idle, and stop positions; moves in and out to shift gears. Accessory is thin-plate edger

POWERED

THAT OLD SAW about the number of ways to skin a cat can also apply to mowing lawns. A look at the field of powered lawn care equipment finds a great variety of basic element configurations. This is indicated by Tables 1 to 11. Also varied are mechanical refinement, capability, adjustability, and adaptability. It's evident that designers of mowers and related equipment have to consider a wide range of consumer requirements. For the same reason, manufacturers have broadened the range of mower types and the numbers of accessories they market—currently the outstanding trend in this product group.

Power—Propulsion: All the products surveyed here have powered cutting units. A basic distinction is made between those also propelled by power and those that operators must push. Most power sources are gasoline engines ranging from ⅓ to nearly 7 hp. Four-cycle engines are most common, but two-cycle units occur in the smaller ratings. Electric motor power is also available on small mowers. All riding types have gasoline engines. In power-propelled mowers, only one uses separate engines for propulsion and cutting.

Engines are started with lengths of rope, free or automatically rewound, and with electric starting motors, battery powered. A Reo accessory is a built-in receptacle by which a mower can be supplied house current momentarily, for starting, thereby eliminating a battery. Reo also features what may be the most novel gas tank, Fig. 1.

Cutting Units: There are four types of cutting units: Rotary, reel, sickle-bar, and the Henderson Cyclo-Safe cutter, Fig. 2. Sickle-bar mowers, by Jari Products Inc., are particularly useful for large areas, rough terrain, and tall grass or weeds. Two models cut paths 36 and 44 in. wide, respectively. Attachments which replace the bar itself include a conventional reel.

ROTORS: Most popular cutting unit is the rotor type—essentially a sickle operating at high power, high speed.

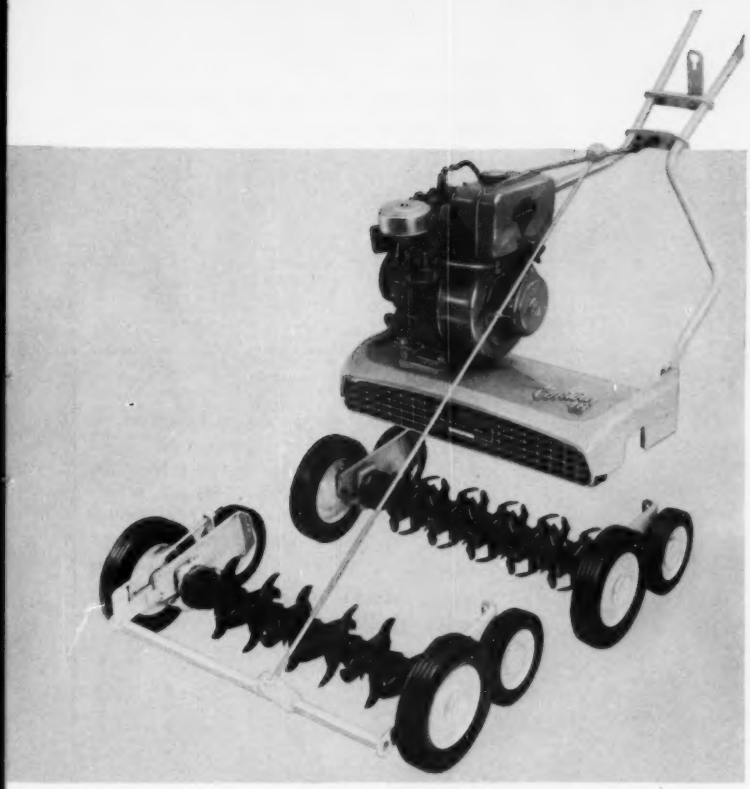


Fig. 2—Multiple vertical rotors with knives at several angles to the ground distinguish Henderson Cyclo-Safe cutter. This assembly rotates away from operator (counter to wheels in forward travel), chops weeds and grass several times down to desired height. On hand-propelled Contour model 134, powered Cyclo-Safe cutter interchanges with Thin-Cut unit. Latter has straight vertical knives that cut to ground level to thin bent-type grass and control horizontal-growing weeds

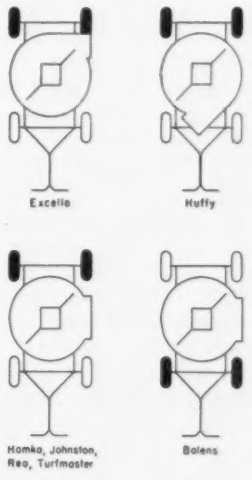
LAWN MOWERS

Mechanically simple, and therefore inexpensive, the rotor can trim tall weeds and coarse grass as well as lawns in better condition. It mulches this growth and anything else in its path—leaves, paper.

Rotors of advanced design are sharpened only at the two ends. Centers are raised to prevent drag on the grass. Lengths of blade are twisted to obtain a vacuum-cleaner action which stands the grass erect during cutting. Some models use this suction to blow cuttings into a catcher.

Rotors, however, need more frequent sharpening than reels, and they can be dangerous. Housings are designed for operator safety, and spring-back blade designs assure

Table 1—
Walking mowers, rotor type, four-wheel, gas-engine propelled



Front wheel drive frees rear wheels to facilitate sharp turning. Operator rocks mower onto its rear wheels then pivots machine like a hand truck. Right front and right side discharge assures that cuttings don't "ball" or form windrows.

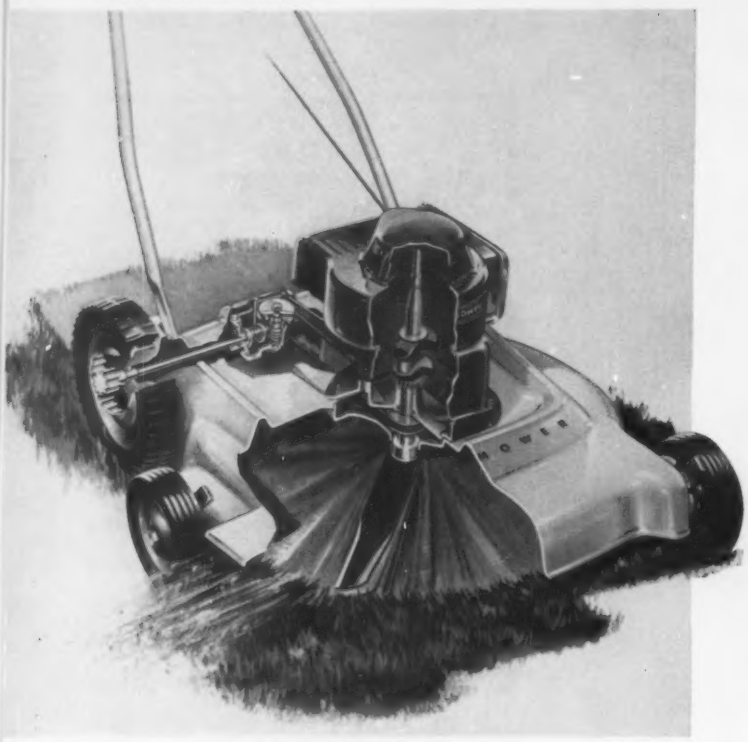
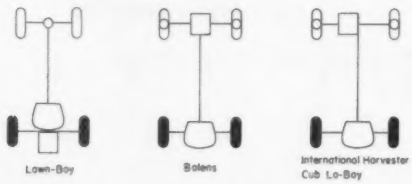


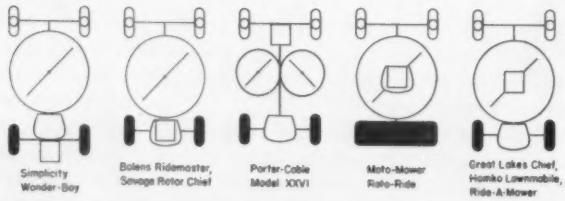
Fig. 3—Worm and wheel enclosed in oil-filled housing transmit power, via belt, to rear wheels of this Moto-Mower model. Further reduction occurs in planetary pairs in rear wheels. Drawing also illustrates blade's vacuum action and right front discharge

Table 7—
Basic prime movers,
riding



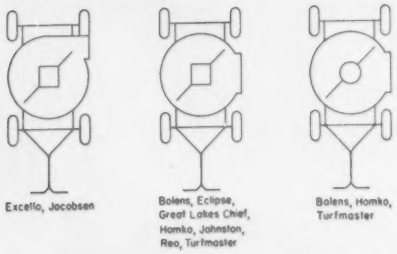
Having essential configurations of tractors, these units receive numbers of accessories which attach or project beyond wheel tread and wheelbase. Wheeled, working accessories for Lawn-Boy substitute for plain front wheel unit.

Table 8—
Riding mowers, four-wheel,
rotor type



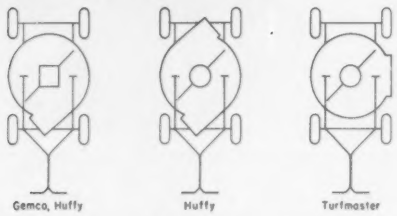
Mainstays of the riding mower field are rotor types. Some divest their rotors to receive other accessories. Others retract rotors to function as tractors. Most are tastefully styled. Moto-Mower's Roto-Ride model uses a drive roller in place of rear wheels.

Table 2—
Walking mowers, rotor type, four-wheel,
hand propelled



Wheels at four corners of mower body is considered most stable arrangement. Right side discharge is said to obstruct least the stream of flying cuttings. Electric power affords quiet operation.

Table 3—
Walking mowers, rotor type, four-wheel,
hand propelled, reversible



Flip-over handles facilitate back-and-forth mowing with minimum turning. This and electric power are suited to small plots. Both-end discharge maintains mower configuration in either direction.

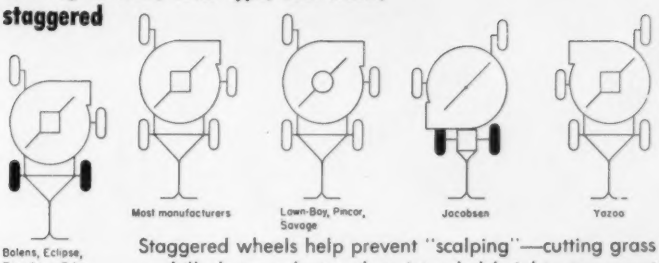
minimum damage to rotors themselves. Several riding tractors that carry rotors have separate clutches and brakes for the rotors alone.

Cutting height of rotors in tractors is accomplished by moving the rotor vertically on its own axis. In smaller mowers, rotor cutting height is adjusted by changing positions of wheel axles. Certain Turfmaster models change height through a parallelogram linkage to all wheels. A common device, by which wheels are moved individually, puts the wheel axis in a notched round plate, the axis of which is eccentric to the wheel axis.

Most rotor-type manufacturers emphasize the importance of the location of the grass chute. This is determined by the convenience of the operator and the point in rotor travel at which centrifugal force throws cuttings off the blade.

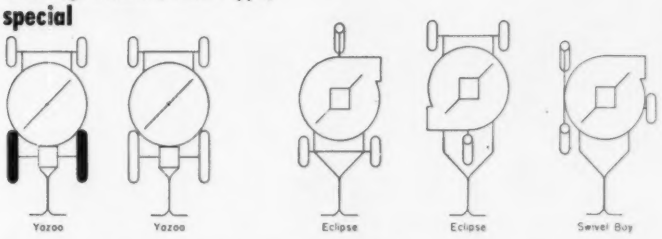
REELS: Some manufacturers claim

Table 4—
Walking mowers, rotor type, four-wheel, staggered



Staggered wheels help prevent "scalping"—cutting grass on hillock tops shorter than intended height at moment front and rear wheels straddle crest. Although popular, staggered wheelers are less stable than four-corner wheelers.

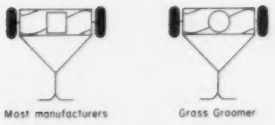
Table 5—
Walking mowers, rotor type, special



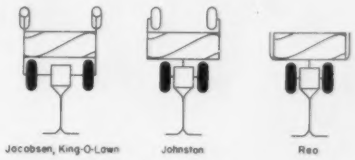
Claimed advantages for oversize rear wheels: They enable fast mower travel; they won't roll into holes thereby affecting cut surface; they serve as safety guards around mower's moving parts.

Maneuverability is main feature of three-wheel configuration—makes mowers particularly suitable for small plots of irregular shape and for mowing close to tree trunks. Small three-wheelers are designed as edgers. Three-wheel suspension helps prevent "scalping."

Table 6—
Walking mowers, reel type



Original application of power to mowers was on conventional two-wheel reel type. Still popular, this type also comes with electric power.



For large areas, reel type mowers have four-point suspension. Configurations in which all wheels are inside the cutting path enable close trim to walls and obstructions. Casters, dolly wheels, and skids help carry load, also function in cutter height adjustments. Addition of towed sulkies converts these models to riding types.

that reels still do a higher quality cutting job than rotors. Scissors-like action does not fray grass ends, and reels operate at slower, safer speeds. Most reels have five or six blades, and seven-blade types are available for cutting fine bent grasses. The Van Ausdale reel has only two blades. Its slowest speed is 700 rpm.

Walking Mowers: Most mowers sold require the operator to walk behind them—pushing the types not self-propelled; guiding those that propel themselves, Fig. 3. A refinement in self-propelled models is a clutch to disengage driving wheels to allow maneuvering in tight spots. Somewhat the same thing is accomplished by having driving wheels in front, Table 1. Wheel size helps to determine the appearance of trimmed lawns. Large wheels are best because small wheels follow too closely the contour of rough ground; cause corresponding uneven cut surface. There are several patterns for wheel arrangement and each has its advantages. See Tables 1 to 6. Power edgers are generally small versions of these mowers.

Riding Tractors: The newest type of mower is the riding tractor—also the most highly styled, Fig. 4. These too have a wide range of basic configurations, Table 8 to 11.

Most mechanical refinements in riding tractors are borrowed from full-size automobiles and tractors. These include: Gear shifting while in motion, automotive differential to prevent tearing turf on turns, multiple speeds forward, pneumatic tires, self-starters, mufflers, adjustable seats, transmission gears bathed in oil. It might be noted, possibly to their credit, that manufacturers haven't yet sprouted fins on their miniature tractors.

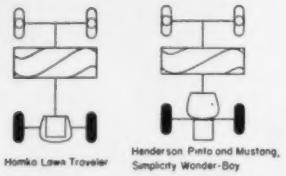
Attachments for riding tractors, besides rotors and single reels, include: Gang reels, aerators, spreader-seeders, rollers, carts, snow blades and plows, lawn sweepers. A novel related item, not drawn by a prime mover, is a powered lawn sweeper by Western Tool and Stamping Co.

Combination Units: A single power unit interchangeable with several kinds of working units gives owners the use of several garden machines without proportional expense. Representative combination units are: Power Handle by Toro Mfg. Co., Yard Marvel by Yard Marvel Mfg. Co., Pow-R-Boy by Hahn Inc., Power-Pak by Bolens Products Div. of Food Machinery and Chemical Corp., and the Cone combination tiller-mower by Gilson Bros. Co.

Reflecting the trend of manufac-

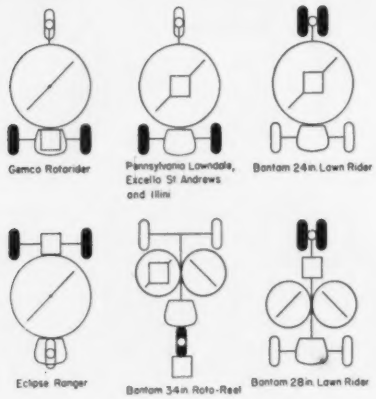
Fig. 4—Angular, boxy styling—trend of the times in other consumer products too—shows up in Toro Whirlwind walking mower and Bolens Ridemaster tractor. Simple stampings form housings, and surfaces are textured or pattern perforated

Table 9—
Riding mowers, four-wheel,
reel type



Older than rotors, reels are still preferred for clean, safe cutting of well-attended lawns. Riding reel mowers are intended for big lawns and parks. Styling is generally functional.

Table 10—
Riding mowers, three-wheel,
rotor type



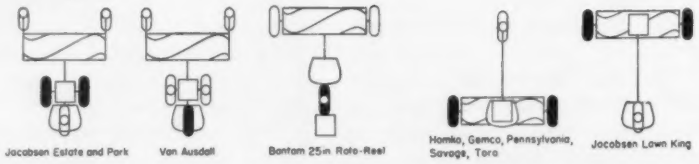
Good maneuverability is an advantage of three-wheel arrangement. On Bantam Lawn Riders, paired front wheels both steer and drive, can turn 180 deg for travel backward. Like four-wheel rotor riders, most three-wheel rotor types are more recent products than reelers. Many are styled and usable as tractors.

turers to broaden lines, Western Tool and Stamping Co. introduces its Power Arm unit this year. Basic element is a 2¾-hp engine with handle, without wheels. It fits three working units: A 22-in. rotary mower, a 9-in. edger-trimmer, and a rotary tiller.

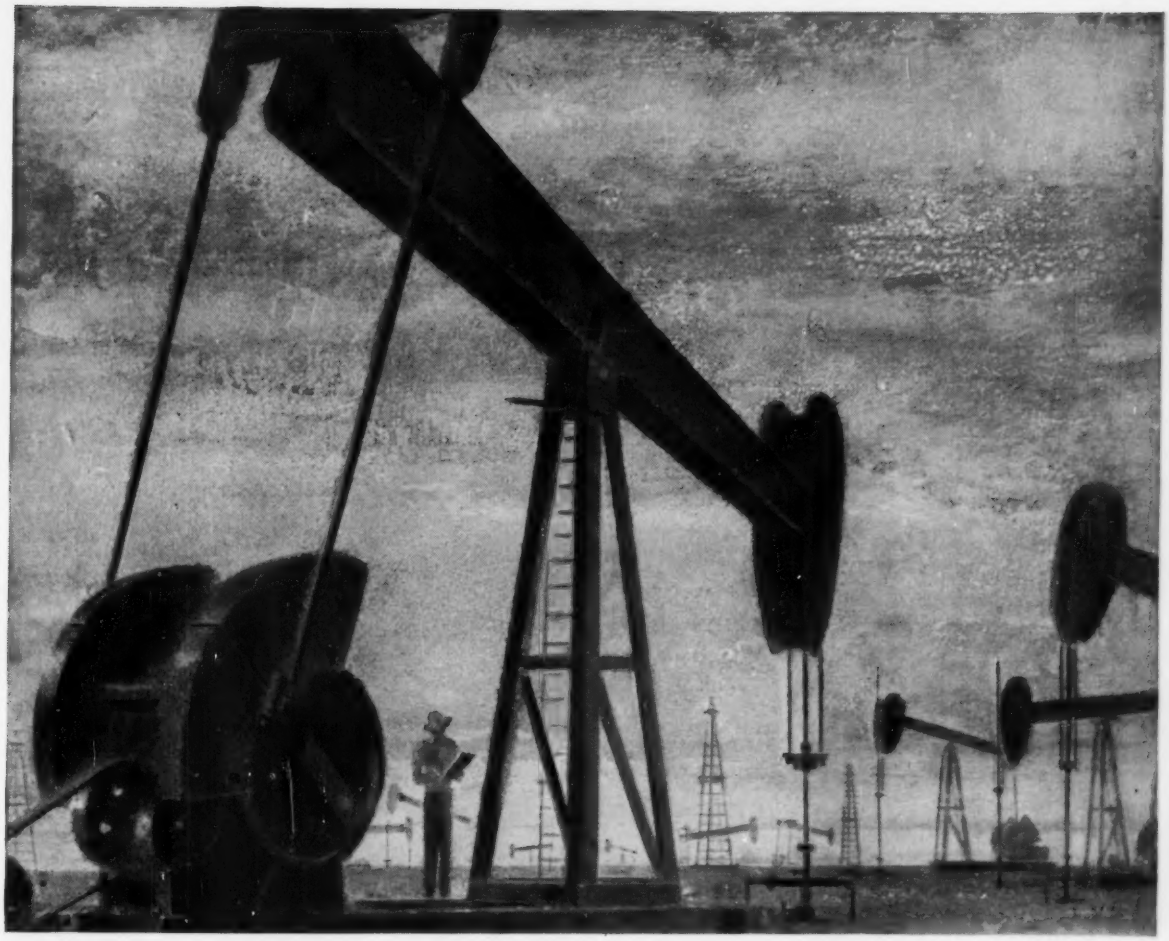
Toro, whose Power Handle combination has dominated its product line, has added units both within and outside the combination class. A new unit to receive the Power Handle is a 25-in., six-blade reel. New fixed-power mowers are two rotaries, 18-in. and 20-in. wide, the latter self-propelled; a 25-in., 6-blade reel; and a 25-in., reel-type 3-wheel rider.

Like Power Handle and Power Arm, the Bolens Power Pak is an interchangeable motor and handle. Unlike them, Yard Marvel and Pow-R-Boy power units include two driving wheels. Advantage of this design is that all combinations made with the basic units are self-propelled. In the Yard Marvel unit, the enclosed chain transmission to the working unit swings forward or behind the engine to accommodate attachments.—S. R. GRIFFITH

Table 11—
Riding mowers, three-wheel,
reel type



Three-wheel reel riders cut paths 2 to 3 ft wide; are intended for large lawns and parks. Maneuverability is excellent particularly with steering wheel in rear. Three models cut full width of wheel tread.



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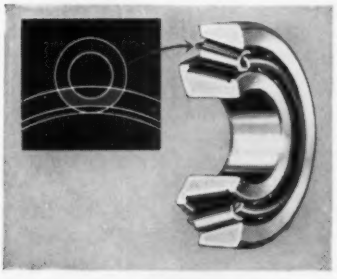


HIGHER FLANGE IMPROVES ROLLER ALIGNMENT

As shown by the gray area above, the higher flange provides a large two-zone contact area for the roller heads. This greatly reduces wear—practically eliminates "end play". Larger oil groove provides positive lubrication.

The flow of America's vital oil can't be regulated by a time clock! These bobbing pumps work around the clock, around the year—with virtually no attention whatever! Dependable Bower Roller Bearings are more than proving their ability to stand this back-breaking pace—doing it with a minimum of maintenance cost and down-time. That's because important Bower Spher-O-Honed design features, like the one shown at left, have reduced bearing failure to a rarity. Whatever test *you* put them to—tractors, machine tools, jet engines—you'll find that Bower Spher-O-Honed Bearings will last longer and operate more efficiently. Let a Bower engineer show you the many advanced design features and superior quality of the complete Bower line. There are tapered, straight and journal roller bearings for every field of transportation and industry.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 14, MICHIGAN

BOWER ROLLER BEARINGS

Circle 413 on Page 19

Supporting Personnel—

Cut the

ONE WORTHWHILE WAY to improve productivity of engineers is to supply them with supporting personnel. Effective use of such personnel can materially speed the progress of work through the engineering department.

As revealed in the survey, *Engineering Manpower: How to Improve Its Productivity,** on which this series of articles is based, many companies are attempting to increase the number of supporting personnel in relation to carefully evaluated needs. At least one company has set up pools of technicians and clerks to be used by its engineering departments. The important point is that such companies have been able to show very noticeable increases in output without corresponding increases in personnel.

There are various types of supporting personnel. Industrial specialists in fields other than engineering include statisticians, computer programmers, and others who are highly trained. Engineering aides include technicians, draftsmen supervised directly by engineers, modelmakers, test equipment assemblers, and others with limited technical training. Also supporting engineers are secretaries, stenographers, and specially trained clerks.

One comment illustrates the engineer's need for supporting personnel:

> • Too many things are left to the engineer which are of mere organizational character . . . a company should make available assistants of good technical background to save time of the creative-minded scientists such that concentration is not destroyed by too much organization, representation, discussions in general meetings, co-ordination, etc. I feel these things weigh too heavily in my daily work.

In assessing the value of supporting personnel for the engineering department, the survey dealt with two considerations: 1. Building the force of supporting personnel. 2. How industry is using its supporting personnel.

Building the force of supporting personnel

As disclosed by the survey, many companies are aware of the value of supporting personnel. Industry in general has made good use of such personnel, wherever they have been used. But the number of companies using supporting personnel in specific programs appears to be relatively small. One possible reason is that the use of such personnel can lead to administration and personnel problems. More important, perhaps, is that some managements do not realize the extent of potential gains.

Building the force of supporting personnel depends upon first evaluating and defining the engineer's duties to differentiate these from subprofessional tasks. Wherever the engineers perform repetitive work or tasks that require only limited background, the use of supporting personnel should be considered. One chief engineer commented:

> • Our company seeks technical people to relieve the engineer of as much routine work as possible. These people not only do drafting, but also letter

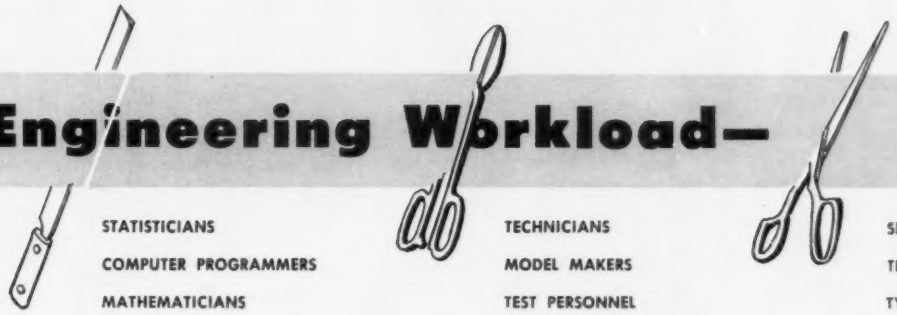
> writing and report writing. This is an important area for better utilization of our engineers.

Technicians form a large and diverse group of engineering aides. They can be used to assist the engineer directly, but they must be intelligently supervised.

Supporting personnel are also being used increasingly for the solution of problems that would require

*© 1957, G. A. von Peterffy

Engineering Workload—



the use of many engineers. On a high level, but certainly definable as supporting personnel, are statisticians, computer programmers, and mathematicians.

Another source of supporting personnel is nontechnical college graduates. Some companies use these people to do administrative work that will release an engineer from these duties. Although they do not supervise engineers, they are able to handle many of the nontechnical administrative problems.

(Women readers, take note!) A great deal of tradition retards the wider use of women for supporting personnel assignments. Engineering and technical work have long been regarded as a man's world. Yet it was found that women are often better suited than men for repetitive, detailed work of the kind required of many technicians. Sheer desperation has forced many an employer to use women for technical jobs that men would ordinarily do, generally with satisfactory results. As a practical consideration, pay scales for women are lower than for men. This has no doubt adversely affected industry's ability to attract women for such positions.

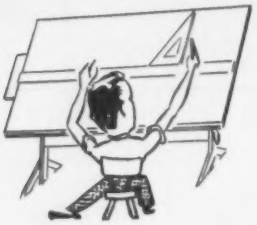
Another major group of supporting personnel covers a broad range of services to engineers. Clerks, stenographers, and library research workers are included in this group. Although these personnel make use of some technical knowledge, they are trained principally in their respective occupations. And yet all members of this group are not static. Many advance toward technician status and higher technical levels. At the same time, they are performing useful work in aiding the central core of engineering effort.

How industry uses its supporting personnel

It was found that the use of supporting personnel has been one of

Checkpoints for Engineering Management

- ☑ **1. Would greater use of supporting personnel improve project progress?**
- ☑ **2. Can current company employees be developed into engineering assistants?**
- ☑ **3. Has your company found an approximate, optimum ratio of technicians for each engineer?**
- ☑ **4. Is engineering assisted by a full range of supporting personnel . . . specialists, technicians, clerical, and others?**
- ☑ **5. Are engineers being trained to accept and work with supporting personnel?**



the most productive means for obtaining fuller utilization of engineering manpower. And yet there were reservations, typified by the comment of a management consulting firm:

> • There is no doubt in our minds that a great deal more could be done in business and industry to use engineering aides, laboratory assistants, laboratory technicians, and others below the graduate-engineer level in order to make more engineer manhours available for research and comparable activities. There is a reluctance in most engineering departments in business to proceed in this direction. Possibly this is in part the normal human resistance to change and possibly in part a reluctance of the engineers to admit that a segment of the work they have been doing could be done by anyone of lower skills or less education.

Engineers' statements reveal an apprehension regarding the use of technicians. Underlying this apprehension is perhaps lack of understanding of the role that supporting personnel play. Technicians are defined in the words of the National Science Foundation:

> • Those workers who aid professional scientists and engineers in research or development work and who are in positions requiring knowledge of the sciences, engineering, and mathematics comparable to that acquired through technical institute, junior college, or other formal, post high-school training.

The survey did not reveal any glaring or common misutilization of technicians, but did show an area of possible problems. The engineer remains receptive to using technicians only when management takes careful measures to control their numbers, activities, and status. If he is allowed to feel that his professional status is being threatened, he will almost invariably exhibit reluctance in properly utilizing technicians.

The role of outside-the-company training can become important here. Frequently firms have a policy that an engineering aide can become a fully recognized engineer on completion of an accepted engineering course at a nearby college. Some companies will subsidize part of this education.

Proper placement, particularly of technicians, is critical to their successful use. If he is not relieving engineers of work, the technician's value is nil. Placing a technician effectively presupposes that each engineer's job has been carefully reviewed, step-by-step, to identify subprofessional tasks.

Once the jobs to be delegated to supporting personnel have been identified, assigning technicians to perform them must be done very carefully. One large electrical equipment company carries on an extensive program to place its technicians. While in the program, a man is placed for three months in a job in which he is interested. He is shifted to other jobs, generally two or three times, until there is mutual agreement between him and the particular department that this is the job for which he is best suited.

The success with which technicians are used to improve an engineer's productivity also depends on how well the engineer can direct the work of his technicians. Some engineers are notably unsuccessful at directing these efforts, but can improve if exposed to in-plant training. Of course, there is some work that would take more time to explain than to do. The point is that many engineers' too-heavy workloads are a long way from the irreducible minimum, and the proper use of supporting personnel can, in a practical manner, do much to alleviate this situation.

Next article in this series will appear in the May 15 issue. It will deal with personnel administration with regard to appraising engineers, special personnel techniques for engineers, and retirement.

Recommendations for Management

1. Evaluate Engineering Tasks

This is fundamental not only to assigning supporting personnel, but also to planning projects, work scheduling and other normal engineering functions.

2. Supplement Engineers' Training

Engineers themselves must be trained to assign responsibility and to work with a team of supporting personnel. Therefore, once management has decided to expand the use of supporting personnel, it should take positive steps to ensure that engineers receive such training.

3. Encourage Engineers' Initiative

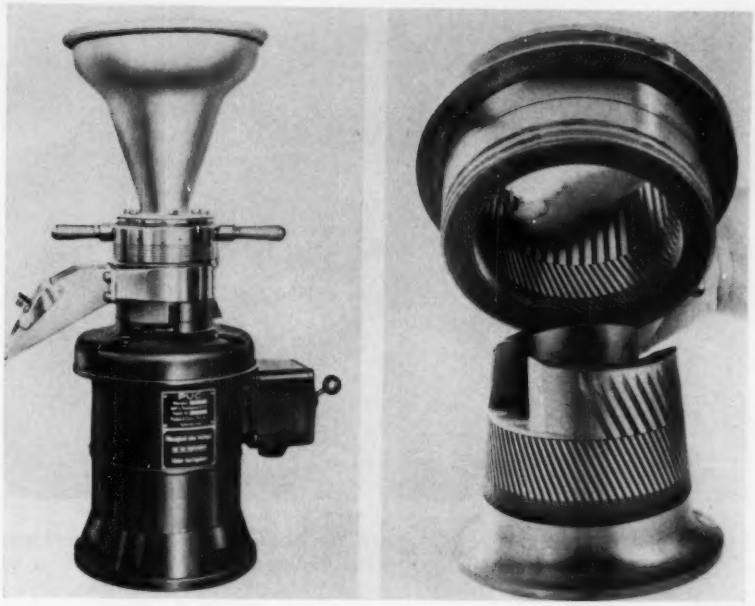
After the engineer has become adept at making use of supporting personnel, he should be allowed the initiative in selecting and using these people. Over-all efforts will be more effective.

4. Manage Technicians Carefully

Management is advised to be alert to possible administrative problems, caused by careless control and administration of technicians. Develop technicians intelligently and permit them room for advancement, but discourage any attempted overlapping in job status.

5. Make Changes Slowly

There are certain potential difficulties when it comes to hiring technical assistants who may represent competition to the engineer. These can be largely avoided by considering the engineer's expectations.



BUILT-IN FORCE FEED distinguishes this multistage dispersion mill which draws material into its working section then ejects the product under pressure. Marketed by The Pfaudler Co., Rochester, N. Y., the new mill performs wet milling and grinding, homogenizing, dispersing, emulsifying, and extracting. Basic parts include a high-speed rotor inside a cylindrical stator. The stator inside wall is grooved for two to five grinding stages, depending on the mill model. Rotor has a corresponding groove pattern. Rotor and stator are arranged to form a milling gap between them. Dimensions and positioning of these parts decrease the gap in the downward direction. Gap is regulated by a calibrated adjustment device. Mill capacity, depending on material processed, is 44 to 33,000 lb per hr.

NEW FORD, the Thames "800" estate bus, is the latest import in the English Ford line of 14 models. The combination utility bus and station wagon carries eight to ten passengers; gives 27-mpg fuel economy. Its four-cylinder, OHV Consul engine develops 59 hp at 4200 rpm. Wheelbase is 84 in.; length, 158.8 in. Ford now imports the entire English line plus six models of its German-built Taunus. This confirms the Company's announcement of last fall that it would consider entering the small-car field when sales if imports reached five per cent of total U. S. market. At current ratio, imports will account for better than 6 per cent of 1958 sales.

"West Point" for Engineers? Educator Says "Yes"

Proposes Science Academy For Brilliant Student

"Yes, we should have a governmental 'West Point' for scientists and engineers," says Prof. B. M. Aldrich of the University of Wichita. This proposal, he contends, would solve many of the present needs for scientific personnel at far less cost than the government-sponsored scholarships now under study, and would produce the top-notch scientists and engineers so vitally needed. Aldrich proposes the U. S. create an Academy of Science and Engineering to be, in the field of science and engineering, what West Point is to the Army.

Staff for the proposed academy would consist of only the best instructors, specialists, and authorities in their respective fields. They would be paid salaries commensurate with their qualifications and abilities. Outstanding scientists of the country could be obtained for special lecture series. Staff members would be encouraged to carry on research along with their moderate teaching duties and to supervise graduate research.

Student body would be composed of the most promising of this country's youth. Colleges and high schools the country over would serve as the field of recruitment, feeding into the student body those outstanding students most likely to meet the rigorous scholastic and aptitude entrance requirements. Students making application would be rigidly screened. Those permitted to enroll would be expected to pursue their studies on through the requirements for the Doctor of Philosophy degree. As incentives, students would be required to pay no tuition and would be paid a salary. They would also be provided with suitable living quarters on the academy grounds.

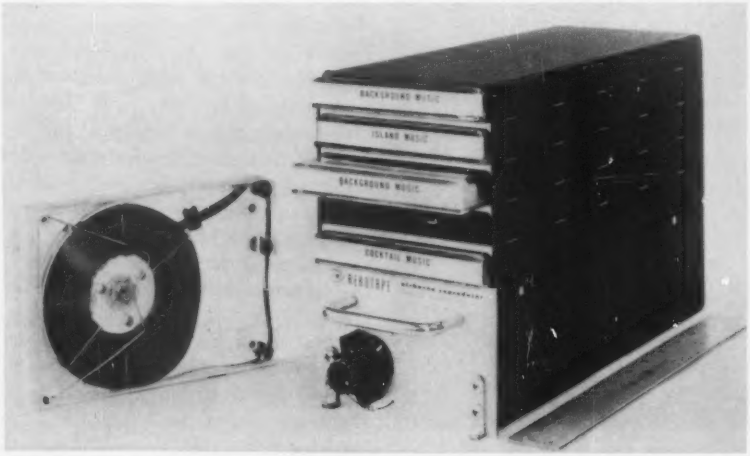
Undergradute advancement would be extraordinary. Students would be advanced just as rapidly as their abilities permitted. The progress and attitude of students would be carefully watched. Those who showed signs of being either unable or unwilling to keep pace and

to give attention to their objective would be dropped from the program. It is believed that graduates would be qualifying for degrees in the brief space of one or two years. The program would be so conducted that students could enter at any time and, upon completion of the requirements in a satisfactory manner, be granted the appropriate degree.

Laboratories and facilities would rate second to none in the world in quality. Government-sponsored research would be carried on here and the academy would have its program tied closely to government-operated developments. Government controlled developments would furnish ample research projects for graduate theses.

Upon graduation, each student would be given an opportunity to continue as an employee of the government, if he so desired, at an attractive salary. By this direct contact with superior students, the government would be in a most favorable position to detect the best qualified graduates and to obtain their services for governmental assignments. The program would supplement the present college system by furnishing the specific and necessary type of training needed by the brilliant student. It would be aimed at providing for both the immediate and future critical needs of our scientific age.

FLYING SPY for the Army, designed for all-weather operation, will use the latest infrared, television, and photographic surveillance equipment to give combat commanders a running account of battlefield conditions. Called SD-2 and developed by Rheem Mfg. Co., the new drone features plastic laminated construction of wing, fuselage, and tail components for easy individual replacement as a package. The SD-2 is zero launched, using rocket assist, and is recoverable by parachute. A typical Army surveillance unit, drones, checkout consoles, launchers, ground-control system, and related equipment will be transported in two standard Army 6 x 6 trucks.



AIRBORNE MUSIC is played by this record, erase, playback unit. Its single reel of magnetic tape unwinds and rewinds simultaneously in an endless loop. Flight personnel can change tape magazines in seconds without removing the machine from the rack and without tape threading. Called the Aerotape, the miniature device was designed by Packard Bell Electronics primarily for military applications, but has application as a music reproducer for commercial airlines. It provides for five 45-minute reels of music, operates on 1 amp at 24-30 v dc.

Ultrahigh-Resolution TV Tube Achieves Microscopic Detail

Uses Phosphor Screen For Photo Transmission

DANVERS, MASS.—An ultrahigh-resolution cathode-ray tube makes possible the microscopic detail and clarity necessary for the transmission of fine photographic information. Developed by CBS-Hytron, the new tube makes use of advanced evaporated-phosphor techniques similar to those announced by the U. S. Naval Research Laboratory.

The tube's major feature — its small, uniform beam — used in conjunction with a very thin phosphor screen of short persistence results in uniform brightness and high resolution throughout the field of scan. Recent 7-in. prototypes provide 12,000-line resolution (as compared with 525-line home TV picture) over the entire screen area.

Claim is made for an intrinsic deflection linearity of better than 1 per cent. A low-drive requirement resulting from unusual design of the electron gun makes the tube suited for use with completely transistorized video amplifiers.

2,000,000 DEFLECTIONS WITHOUT FAILURE.....Severe fatigue tests show Duraflex,® Anaconda superfine-grain Phosphor Bronze, permits far higher design stress

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Complete engineering and manufacturing service; including design and development of special machinery, mechanical products and spring actuated mechanisms. Stress analysis, spring design, metallurgical data, heat treatment, plant layout, engineering reports, selection of materials and equipment. Tools and products.

The American Brass Company,
99 Park Avenue,
New York 16, New York.

October 25, 1957.

Gentlemen, SUMMARY OF ENGINEERING LABORATORY REPORT NO. 102557

SUBJECT: Fatigue Life Test of "Duraflex", Superfine-Grain Phosphor Bronze and Commercial Quality Grade A Phosphor Bronze spring wire.

SPECIMENS: Compression springs made from each material, were coiled on arbors to avoid tool marks. The springs had squared ends, a high pitch to obtain high stresses and were heated after coiling in boiling water for 1 hour to relieve residual coiling stresses.

CALIBRATIONS: Each spring had its physical dimensions measured with micrometers and vernier calipers and was load tested in a Comaco Elasticometer Precision Spring Testing Instrument, before fatigue testing and after each 100,000 cycles of deflection to determine loss of load, if any.

FATIGUE TESTING: A representative number of springs from each material were tested simultaneously under identical conditions.

STRESSES: The stress in the springs, including curvature correction, during the tests were as follows:

Stress at Initial Installed Position	36,600 p.s.i.
Stress at Final Deflected Position	73,200 p.s.i.
Stress Range during deflection	36,600 p.s.i.

These stresses, for endurance limit testing, are exceptionally high for phosphor bronze spring wire - far higher than those ordinarily recommended for Beryllium-Copper or Stainless Steel for such severe service and are comparable to those used for good quality Spring Steel.

RESULTS: Grade A Springs broke at average deflections of 505,700.

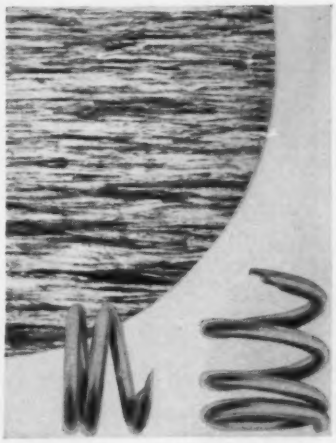
Duraflex Springs were still satisfactory with no appreciable loss of load at 2,000,000 deflections.

CONCLUSIONS: 1. Design stresses for Duraflex can be at least 33% higher than those used for Grade A Phosphor Bronze and as high if not higher than design stresses recommended for Beryllium Copper.

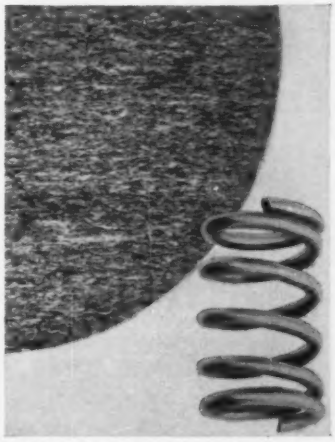
2. High endurance and long fatigue life at high stresses can be expected from springs made of Duraflex Phosphor Bronze.

CERTIFICATION: We certify the above summary of our report is accurate, in accordance with the facts and is true in every respect.

Respectfully submitted,
THE CARLSON COMPANY
Harold C. H. Carlson
Harold C. H. Carlson, P.E.
Licensed Professional Engineer.



Spring of Alloy A Phosphor Bronze, shown actual size, which broke just after 500,000 deflections. Micrograph (75x) shows typical grain structure of this metal.



Spring of Duraflex showed no appreciable loss of load after 2,000,000 deflections in same test. Micrograph (75x) shows typical superfine-grain structure of Duraflex.

Duraflex is a registered trade-mark for a higher quality phosphor bronze in sheet and wire forms, recently developed by American Brass Company research. Yet it costs no more than regular phosphor bronze. For detailed information—for a copy of the test data—write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5845

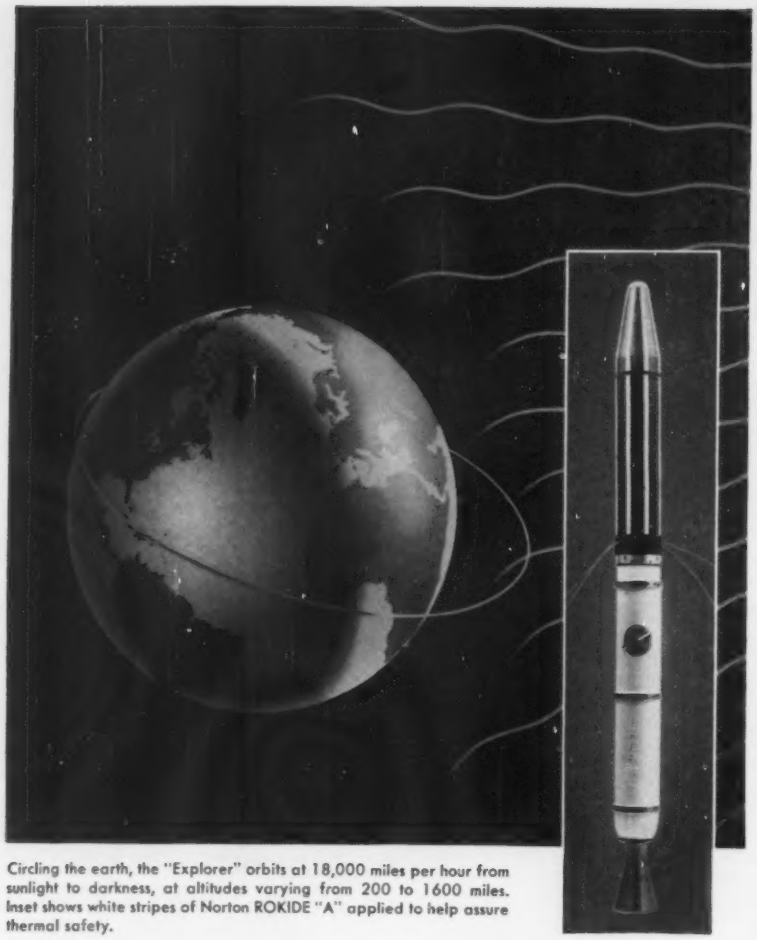
DURAFLEX

Superfine-Grain Phosphor Bronze

A product of

ANACONDA®

Made by The American Brass Company



Circling the earth, the "Explorer" orbits at 18,000 miles per hour from sunlight to darkness, at altitudes varying from 200 to 1600 miles. Inset shows white stripes of Norton ROKIDE "A" applied to help assure thermal safety.

Hotter than fire . . . colder than ice

ROKIDE coating protects the "Explorer" through temperatures from 600°F to 150° below zero.*

Completing its orbit every 118 minutes, the "Explorer" speeds between blazing daylight and black night every hour, through temperatures ranging from 600°F to 150°F below zero.

The resultant thermal risks, especially to instruments, are enormous. By striping the satellite's nose cone and instrument section with ROKIDE "A" aluminum oxide spray coating, Jet Propulsion Laboratory scientists were able to maintain a safe internal temperature range.

ROKIDE "A", "ZS" and "Z" coatings are hard, crystalline refractory oxides. These Norton developments have high resistance to excessive heat, abrasion and corrosion that has proved valuable not only in reaction motors and AEC projects, but to general industry..... ..... in applications involving electrical insulation, electronics, bearing surfaces, erosion resistance, chemical barriers, material upgrading, surface catalyst activity and altering emissivity and characteristics of surfaces.

Facilities for applying ROKIDE coatings are maintained at Norton Company, Worcester, Mass., and at its plant at 2555 Lafayette Street, Santa Clara, Cal. For the latest ROKIDE Bulletin write to NORTON COMPANY, 764 New Bond Street, Worcester 6, Massachusetts.

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NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals
BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

Develop Portable Maser Stable to One Part in 10^9

Research Standard Permits Checking Present Theories

BROOKLYN, N. Y.—A portable maser oscillator tube generates a frequency of 23,8270.1294 mc $\pm$500 cps with a stability of better than one part in 10^9. Developed at Polytechnic Research & Development Co. Inc., the portable frequency standard is said to have an excellent future as a basic research tool for establishing new theories and re-evaluating existing ones.

Operation of any maser (coined from the phrase, "microwave amplification by stimulated emission of radiation") using ammonia, is based on the flow of ammonia molecules into an electrostatic field, called the focuser. This concentrates upper-energy molecules into a narrow beam which permits passage into a high-Q cavity. At the same time, molecules in the lower energy states are deflected away from the beam and condense on the walls of the focusing chamber, which are cooled by liquid nitrogen.

Each ammonia molecule (NH_3) may be regarded as a pyramid with one hydrogen atom at each corner of its base and a single nitrogen atom at its apex. Periodic vibration of this nitrogen atom, up and down through the base of the pyramid, gives ammonia its characteristic frequency of 28,370 mc. Position of the nitrogen atom at any instant determines energy level of the molecule.

When ammonia molecules enter the high-Q cavity, transitions of the molecules to their lower energy states result in stimulated emission of electromagnetic energy at a stable frequency. With enough molecules present in the molecular beam, the resultant electromagnetic field is strong enough to sustain oscillation.

The portable maser is capable of a minimum of 500 hours without the necessity of breaking the vacuum seal. The device has been designed so that the ammonia may be recirculated to the reservoir after approximately 50 hours of operation. The time required to recircu-

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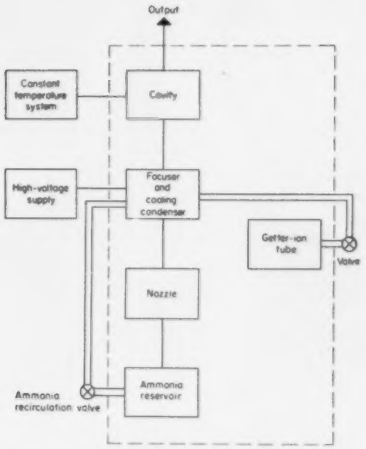


In ammonia-maser oscillator tube, unique design for recirculating the ammonia to the reservoir after 50 hours of operation eliminates the need for auxiliary pumping equipment. Getter-ion tube maintains high vacuum in the system

late the ammonia and to render the unit operative again is slightly in excess of one hour and can be performed by an unskilled technician. Replacement parts at the end of operational life render the tube completely usable for an additional 500 hours.

Invar has been used in construction of the cavity to assure stability. Also to assure stability, an enclosed system controls temperature to within ±0.02 C. Liquid nitrogen must be added to the cooling condenser at the rate of ¼ pint every hour to maintain proper temperature.

Meetings

AND EXPOSITIONS

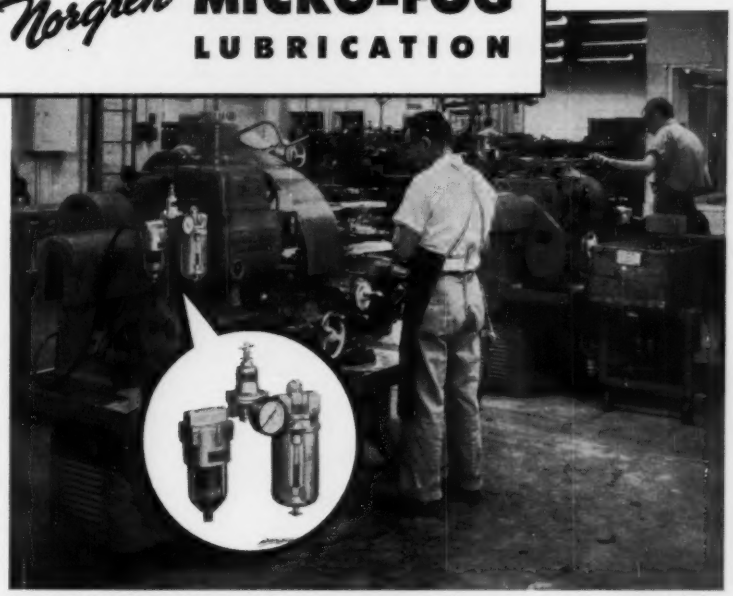
May 14-16—

Society for Experimental Stress Analysis. Spring Meeting to be held at the Hotel Manger, Cleveland. Further information is available from the society, P. O. Box 168, Cambridge 39, Mass.

May 19-23—

American Foundrymen's Society. 1958 Foundry Show will be held in

FACTS about Norgren MICRO-FOG LUBRICATION



Norgren MICRO-FOG lubricates all bearings, gears and other components on this turret lathe.

Continuous, Automatic Lubrication for Bearings*... Oil Always Fresh and Clean

- ***Bearings given Ideal Lubrication*** — Just the right amount of oil is applied to provide the best possible lubrication. Bearings run cooler by as much as 20° F. Bearing wear is minimized, reducing maintenance and replacement costs.
- ***Saving in Lubricant is Big*** — Using only a few ounces of oil per day, MICRO-FOG provides more thorough lubrication than other methods using considerably more.
- ***Costs for Equipment are Less*** — Sumps, pumps, oil filters and high pressure piping are all eliminated by MICRO-FOG, providing a big cut in equipment requirements. Also, fewer oil seals are needed, reducing costly maintenance and down-time.

A MICRO-FOG Lubricator creates an air-borne fog of extremely fine particles of oil that can be appropriately distributed to all lubrication points of even a large machine, automatically lubricating with a continuous, fully protective film of fresh, clean oil.

*Also provides ideal lubrication for gears, chains, cams, slides, ways and other machine components.

For complete information, call your nearby Norgren Representative, or write for No. 900 CATALOG.

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If it's Norgren... It's Dependable.

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Circle 416 on Page 19

CHEMISEAL® NYLON

performer

Design to use Chemiseal Nylon (du Pont ZYTEL) for those mechanical and electromechanical parts that must be strong, durable, wear resistant. It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases. And it is the lowest priced of the standard nylon compositions.

Coupled with U.S.G.'s Injection Molding "know-how"—Chemiseal Nylon assures you the lowest cost, precision parts, in volume production. And we specialize in handling designs difficult to mold.

U.S.G. Nylon service goes all the way—offering not only injection molding of parts but also a complete stock of bubble-free Nylon rod, standard and pressure tubing, tape and extruded shapes. In addition, extensive, specialized facilities for high speed automatic machining of parts from stock to your specifications.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

conjunction with the AFS Castings Congress at the Public Auditorium, Cleveland. Further information is available from society headquarters, Golf and Wolf Roads, Des Plaines, Ill.

May 26-27—

American Institute of Electrical Engineers. Ninth Annual Appliance Technical Conference to be held at Hotel Morrison, Chicago. Additional information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

May 26-30—

National Packaging Exposition to be held at the Coliseum, New York. Concurrently, 27th National Packaging Conference of the American Management Association will be held May 26-28 at the Hotel Statler. Further information can be obtained from AMA headquarters, 1515 Broadway, New York 36, N. Y.

June 2-3—

Society of Naval Architects and Marine Engineers. Annual Spring Meeting to be held at the Chamberlin Hotel, Old Point Comfort, Va. Additional information is available from society headquarters, 74 Trinity Place, New York 6, N. Y.

June 2-4—

American Gear Manufacturers Association. Annual Meeting to be held at the Homestead, Hot Springs, Va. Further information can be obtained from AGMA headquarters, 1 Thomas Circle, Washington 5, D. C.

June 2-4—

National Fluid Power Association. Spring Meeting to be held at the Bedford Springs Hotel, Bedford, Pa. Further information is available from NFPA headquarters, 1618 Orrington Ave., Evanston, Ill.

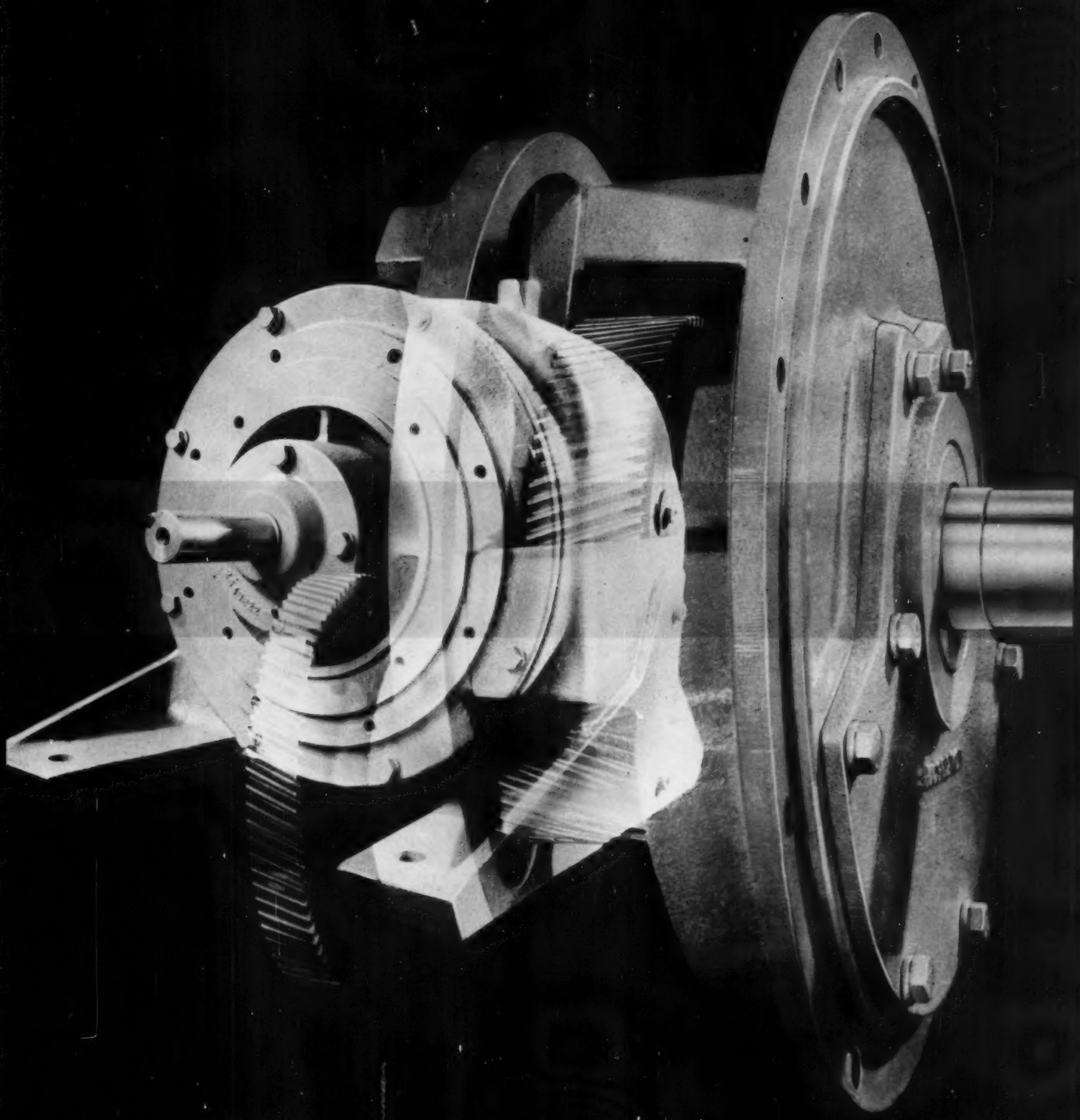
June 8-13—

Society of Automotive Engineers. Summer Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Further information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Circle 417 on Page 19

Circle 418 on Page 19→

EXCLUSIVE DEVELOPMENT OF WESTINGHOUSE ELECTRIC CORPORATION

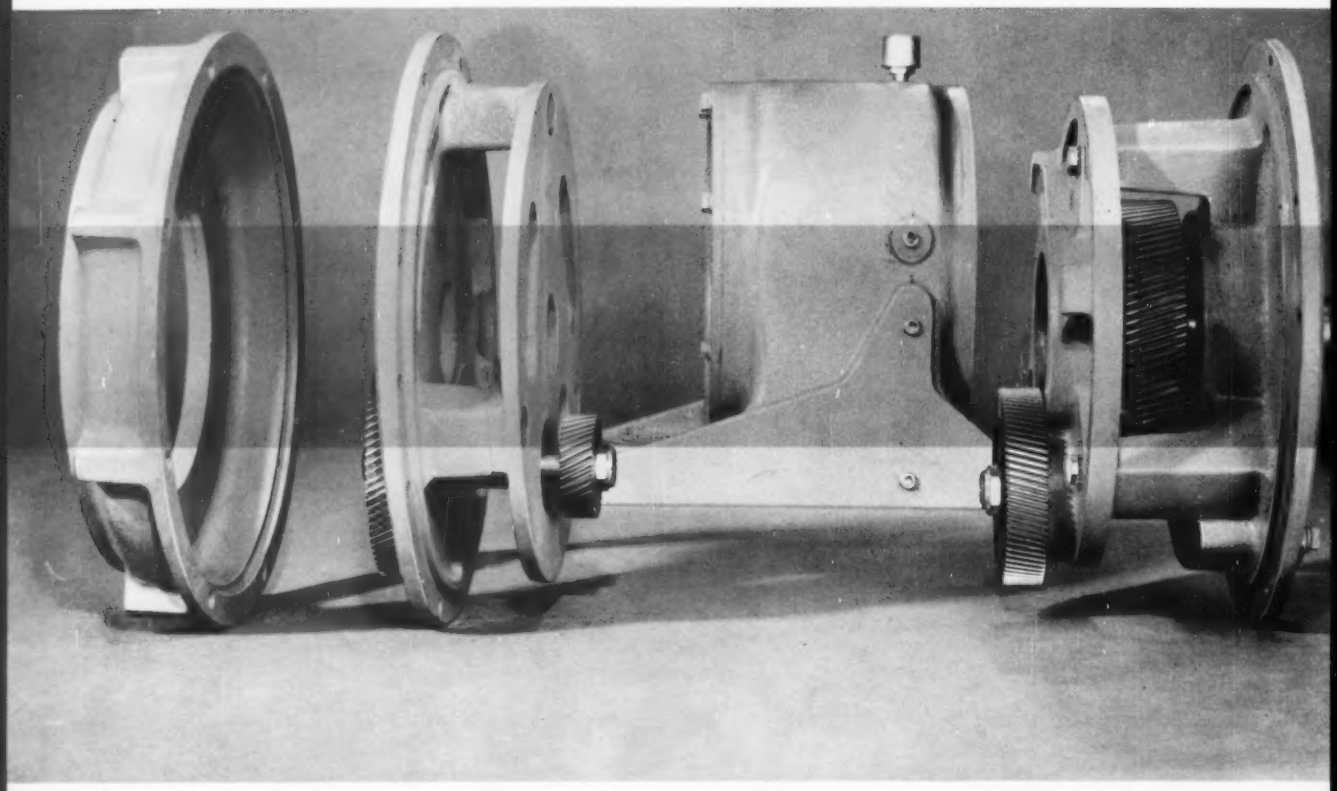


NEW MODULINE GEAR UNITS

OFFER YOU ORIGINAL ADVANTAGES IN
SIMPLICITY • VERSATILITY • DEPENDABILITY

MODULINE

IS ORIGINAL IN SIMPLICITY...IN VERSATILITY



Basic Moduline components combine to form double, triple or quadruple reduction speed reducers, gearmotors or package motor reducer drives with gear ratios from 4.17:1 to 985.3:1.

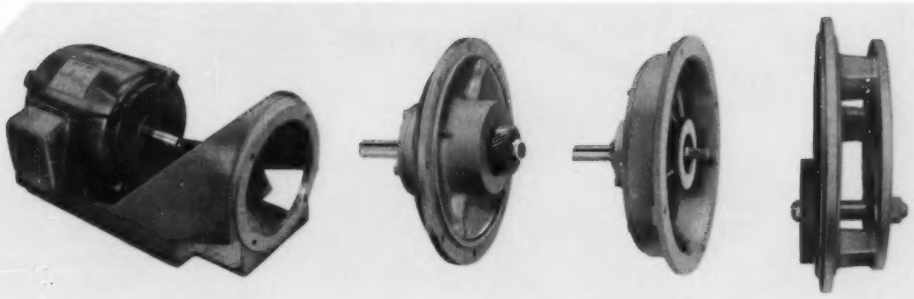
These preassembled modules standardize over 20,000 variations of gearmotors, speed reducers and package motor reducer drives

Look over the simplicity, dependability and versatility you get from Westinghouse Moduline gear units. Here you'll find original answers to solve long-standing problems in application of gearmotors and package motor reducer drives from 1 to 30 hp; foot-mounted speed reducers from 1 to 75 hp; and shaft-mounted speed reducers from 1 to 40 hp, including concentric shaft and right angle configurations.

What's more, just seven Moduline frame sizes cover these broad ranges. By ordering Moduline drives, together with any type of Westinghouse Life-Line® motors, you combine two purchases in one order with complete assurance of design and application coordination.

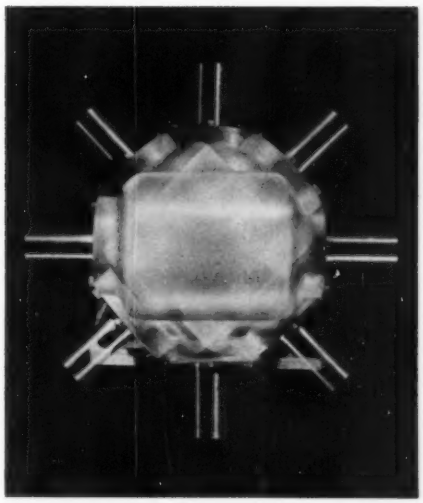
JI-07368-2

EXCLUSIVE DEVELOPMENT OF



Moduline originality offers application and maintenance savings

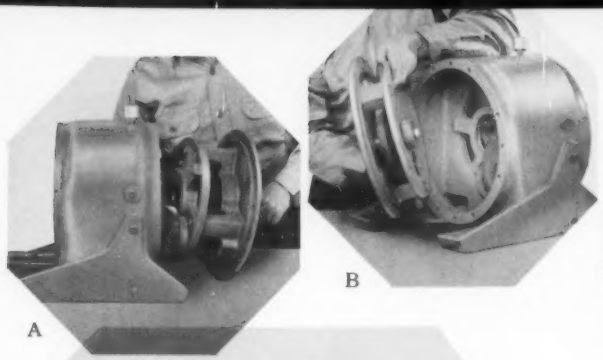
Here are subassemblies for the most versatile gear drives on the market. From these modules . . . concentric shaft or right angle . . . integral gearmotors, package motor reducer drives and speed reducers can be assembled exactly to your specifications. Motor support brackets, right angle heads (in fact, all Moduline parts) go together in thousands of different ways to make the right drive for any job.

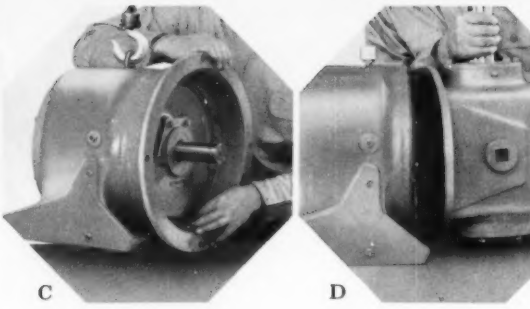


Moduline units can be installed in any location. Concentric shaft units can be mounted in any position on the floor, wall or ceiling . . . or at any angle in between. The output shafts of right angle units can be indexed in 8 or 12 positions for power take-off in almost any direction. Units are designed for electric motor or engine drive; chains, belts or gears may be used to put power into or take it out of them. Only Westinghouse offers Moduline units with right angle input or output assemblies. These 1 to 75 hp reducers with ratios from 7.6:1 to 985.3:1 can handle any job.

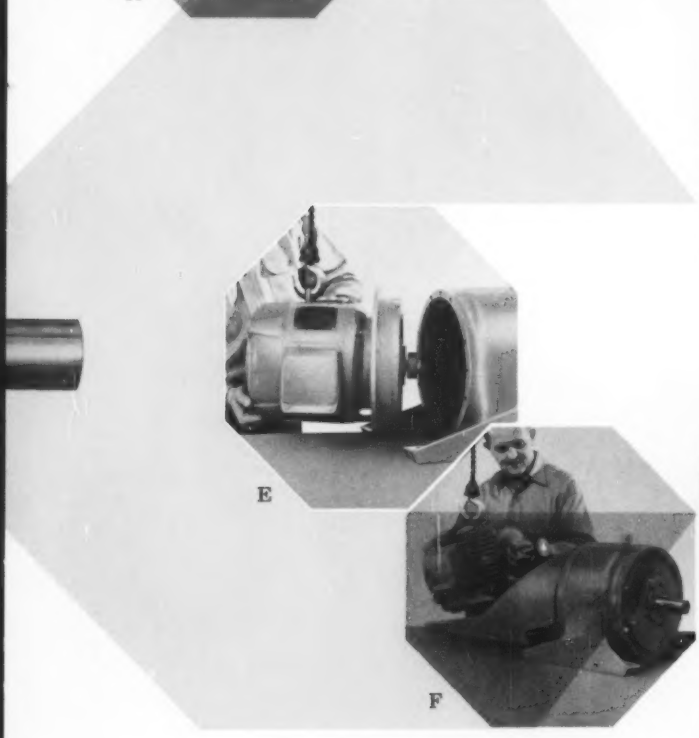
JI-07368-3

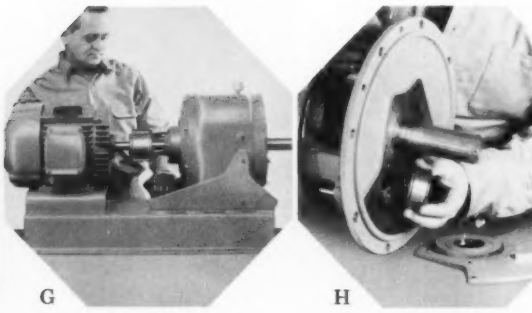
WESTINGHOUSE ELECTRIC CORPORATION





For *speed reducer* assemblies (above), reducer case and h
speed cage assembly with 5:1 gear ratio combine with hi
speed change pinion and gear set (A) which are available
nine standard ratios from 1:1 to 5:1 and for double reducti
up to 25:1. For triple and quadruple reductions, add cha
gear set and high-speed cage assembly (B) . . . with eithe
5:1 or a 25:1 ratio . . . for total ratios up to 625:1. For *vert*
mounting, add flange and face-type seal (C). For *right a*
output units, add head assembly (D).





Gearmotors and package motor reducer drives are assembled w
AGMA standard flange-mounted motor (E) or NEMA stand
foot-mounted motor, with either "sugar scoop" motor supp
(F) or combination bedplate (G). Backstop kit (H) can
added to any unit.

A standard wrench assembles or modifies any Moduline unit

Only a wrench is needed to work on Moduline units. Awkward gear pullers and troublesome fitting have been eliminated. It's another example of the original advantages you gain from Moduline design and quality.

Unusual manufacturing processes, preassembly and pilot fits make modular construction possible. All parts are accurately machined within very close tolerances. No checking, aligning or positioning of modules is necessary during assembly.

Moduline shafts are roll-formed to provide splined and threaded extensions for simple gear mountings. Pinions and gears have splined bores for ease of assembly. An elastic stop nut locks them in position.

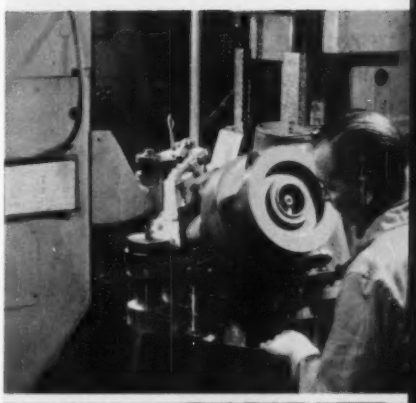
JI-07368-4

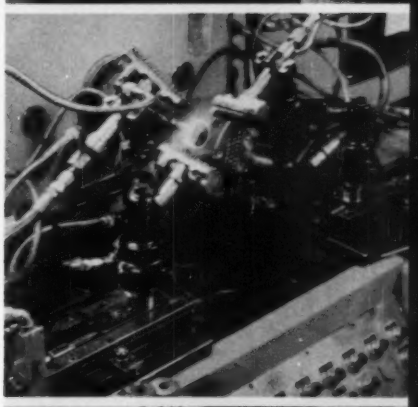
WESTINGHOUSE

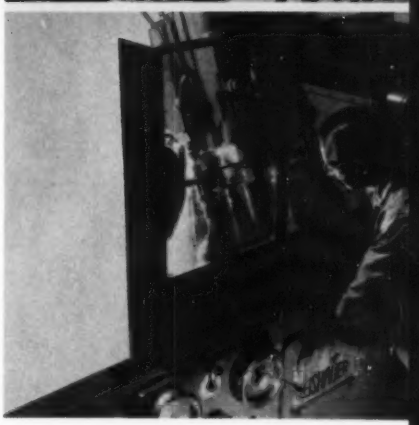
MODULINE

IS ORIGINAL IN DEPENDABILITY

Compare the Moduline ground tooth gear (left) with conventional gear. Note smooth finish, splined bore and drop-forge blank that's standard with all Moduline gears.







(*top*) Precision hobbing cuts Moduline gear teeth on alloy steel blanks

(*middle*) Through-hardening on automatic spin-flame equipment for extra wear resistance

(*lower*) Finish grinding to master gear standards

Only MODULINE combines ground "master gear" precision with tough, wear and shock-resistant alloy steels

See the difference between a conventional gear and a Moduline precision-ground, heat-treated gear. Moduline gear teeth are so accurate they meet AGMA master gear requirements for pin dimensions, pitch error, profile error and lead error. This means unusual dependability with quiet, efficient operation. Previously, you would have to special-order and pay a premium for the quality now made standard by Moduline. These precision gears have low sound levels and increased mechanical capacity. Spin-flame heat treatment and tempering produce hard, wear-resistant surfaces backed up by tough-hardened cores to stand up under all kinds of service.

JI-07368-5

MODULINE

delivery is fast because it's "built in"

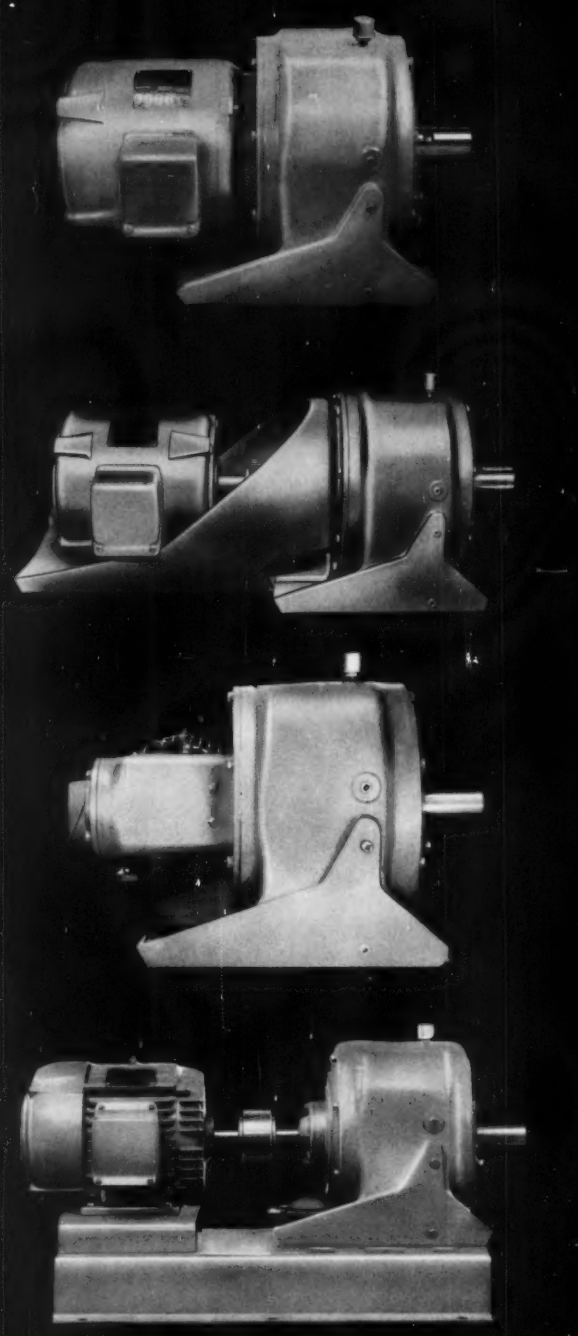
Original moduiar design and complete standardization of components simplifies specification, inventory control and gives fast deliveries from local Westinghouse warehouses.

Your local Westinghouse sales office fills your order from a nearby warehouse. Moduline drives are shipped completely assembled to your instructions, ready to go to work. All Moduline warehouses also carry complete stocks of renewal parts and subassemblies for the maintenance or modification of customer units. Fast parts deliveries and serviceability of Moduline designs reduce down time and maintenance costs to a minimum. A small inventory backs up many units for customers who prefer to stock their own parts and subassemblies.

...see MODULINE facts in action

A desk-top demonstration of Moduline scale models is the first step to lower gear drive costs. Your Westinghouse sales representative will arrange a demonstration; or write Westinghouse Electric Corporation, Gearing Division, 200 McCandless Ave., Pittsburgh 1, Pa.

JI-07368-6



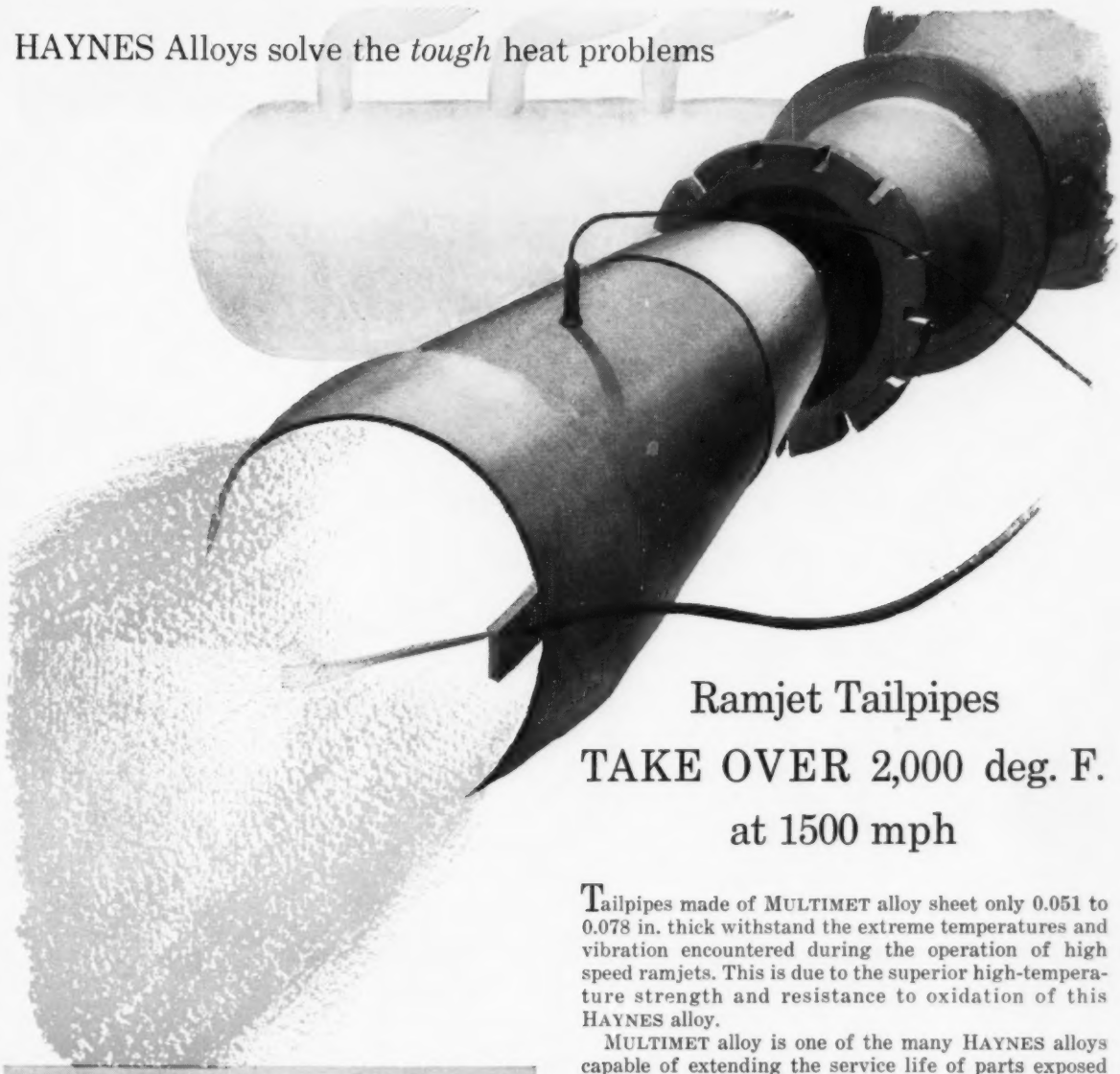
POWER-UP with MODULINE

a complete line of . . .
speed reducers . . . gearmotors . . .
and motor reducer drives

YOU CAN BE SURE...IF IT'S

Westinghouse

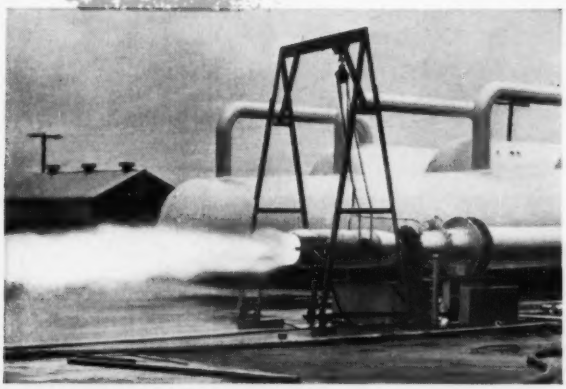
HAYNES Alloys solve the *tough* heat problems



Ramjet Tailpipes TAKE OVER 2,000 deg. F. at 1500 mph

Tailpipes made of MULTIMET alloy sheet only 0.051 to 0.078 in. thick withstand the extreme temperatures and vibration encountered during the operation of high speed ramjets. This is due to the superior high-temperature strength and resistance to oxidation of this HAYNES alloy.

MULTIMET alloy is one of the many HAYNES alloys capable of extending the service life of parts exposed to high temperatures, oxidation, and stress. For descriptive literature write HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana. Or contact our nearest sales office . . . Chicago, Cleveland, Detroit, Houston, Los Angeles, New York and San Francisco.



Ramjet tailpipes are formed from MULTIMET alloy sheet in four sections. The entire assembly is over 2 ft. in diameter at the large end and nearly seven ft. long.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

The terms "Haynes," "Multimet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Never before such capacity in so small

New Adlake little giant

packs 75 amps. into
$4^{23}/_{32}$" x $2^{1}/_{16}$" x $2^{3}/_{16}$"

Here is exceptionally high interrupting capacity in the smallest bulk ever achieved—an ingenious design tested and built to serve indefinitely.

Scaled down in everything but performance, all the notable values of Adlake mercury-to-mercury relays are here, including a molded coil, impervious to time and usage.

The Little Giant, Type 1141, offers the long-proved advantages of Adlake design and construction: Perfect snap action without burning, pitting or sticking . . . fixed, tamper-proof time delay characteristics . . . protection from dust, dirt, and moisture in a hermetically sealed case . . . quiet, chatterless operation. Like all the dependable Adlake relays, Type 1141 will require no maintenance.

Our engineers will be happy to help you with your control problems — no obligation. Write The Adams & Westlake Company, 1173 North Michigan, Elkhart, Indiana.

The Adams & Westlake Company

New York . . . ELKHART, INDIANA . . . Chicago

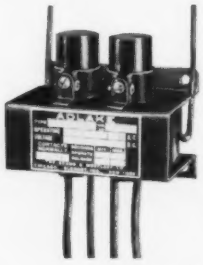
Original and Largest Manufacturer of Plunger-type Relays

Established 1857

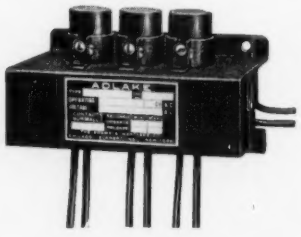
Four Popular Models from Adlake's Complete Line

Type 1140

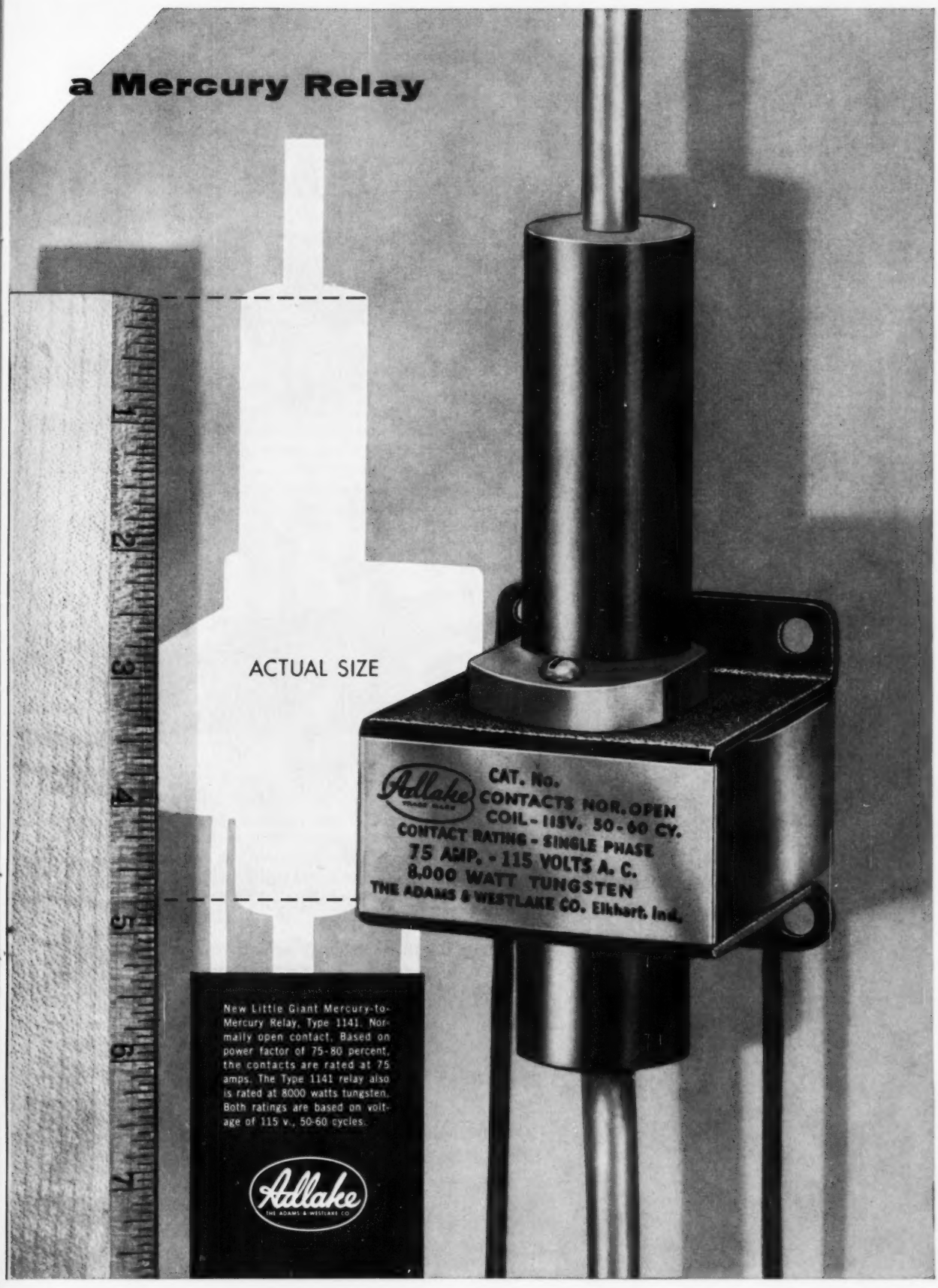
Type 1101



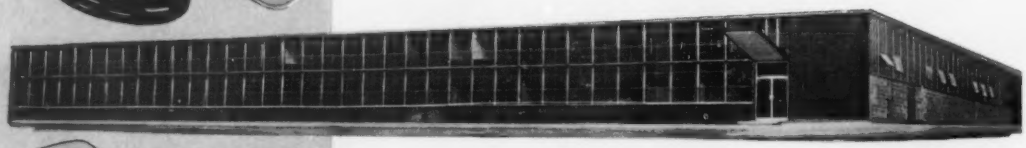
Type 1123



Type 1133

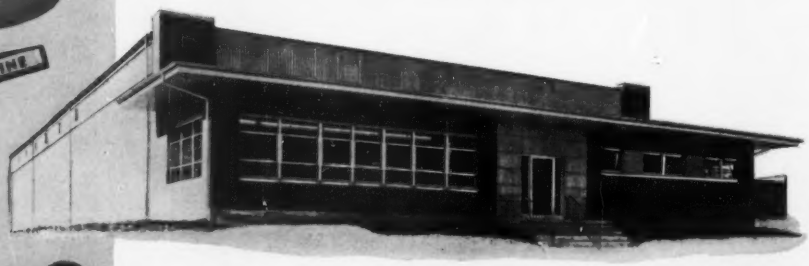

a Mercury Relay
ACTUAL SIZE
Adlake
CAT. No.
CONTACTS NOR. OPEN
COIL - 115V. 50-60 CY.
CONTACT RATING - SINGLE PHASE
75 AMP. - 115 VOLTS A. C.
8,000 WATT TUNGSTEN
THE ADAMS & WESTLAKE CO. Elkhart, Ind.
New Little Giant Mercury-to-Mercury Relay, Type 1141. Normally open contact. Based on power factor of 75-80 percent, the contacts are rated at 75 amps. The Type 1141 relay also is rated at 8000 watts tungsten. Both ratings are based on voltage of 115 v., 50-60 cycles.
Adlake
THE ADAMS & WESTLAKE CO.

INJECTION MOLDING BY CONSOLIDATED



Scranton, Pennsylvania:

The caption takes on added meaning with the opening of our fine new plant, exclusively devoted to injection molding. Located in Lackawanna Valley's Industrial Park, it contains 80,000 square feet of space on one floor and houses 23 injection presses plus unexcelled spray painting, metallizing, and other decorating and finishing facilities. There will be no better injection plant in the East—and no more experienced or knowledgeable production staff.



Binghamton, New York:

New York State manufacturers now enjoy the added convenience of this new addition to our injection molding facilities. Twenty thousand square feet of floor space, seven modern injection presses, new dimensions in decorating and finishing—all these and a sound organization, too, are right on the spot to serve you better.

Whatever your injection molding need, Consolidated has the wherewithal to serve you to your complete satisfaction. Two new plants in operation have equipped us better than ever before to handle any injection molding job. Why don't you see for yourself what our expansion—backed by long experience—can mean to you?

"Your Blueprint in Plastics Since 1874"

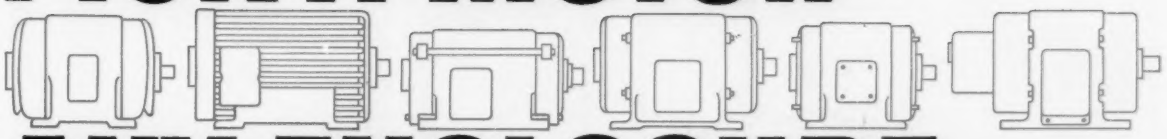
At Consolidated, Everything is Modern Except Our Old-Fashioned Pride in Craftsmanship

CONSOLIDATED MOLDED PRODUCTS CORPORATION

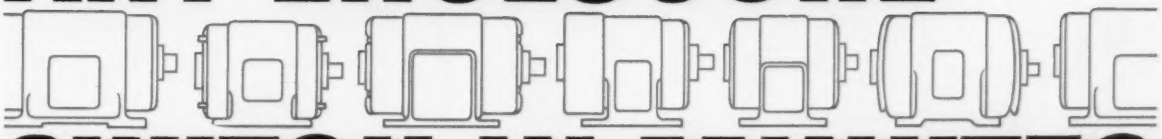
Scranton, Pa. and Binghamton, N.Y.

With a LINK-BELT Motogear—you can

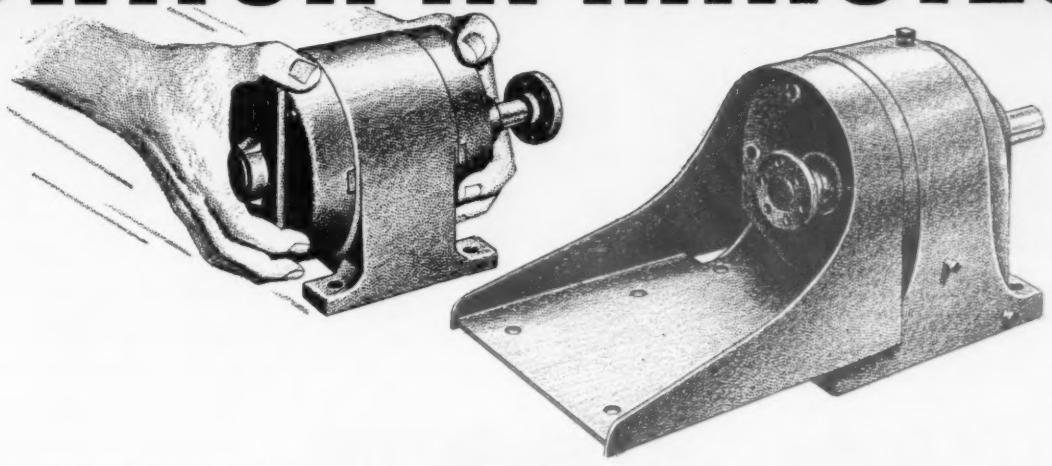
PICK A MOTOR



ANY ENCLOSURE



SWITCH IN MINUTES



DESIGNED for bracket-mounting foot-type motors of *any* manufacturer, Link-Belt Motogears radically slash delays in making motor replacements. Remove four bolts, disengage the coupling, re-assemble with another motor —and it's ready for work. No need to drain oil. And no re-alignment problems — the bracket assures accurate positioning of the motor.

Link-Belt Motogears are immediately available from nearby stocks, in sizes to 100 hp, output speeds from 280 down to 1.8 rpm. Call your nearby Link-Belt office for complete information.

ASK FOR BOOK 2447 — contains features and data on Link-Belt Motogears. Also covers Gearmotors — with flange-mounted NEMA motors—and Electrofluid Motogears with *"Cushion Action."*

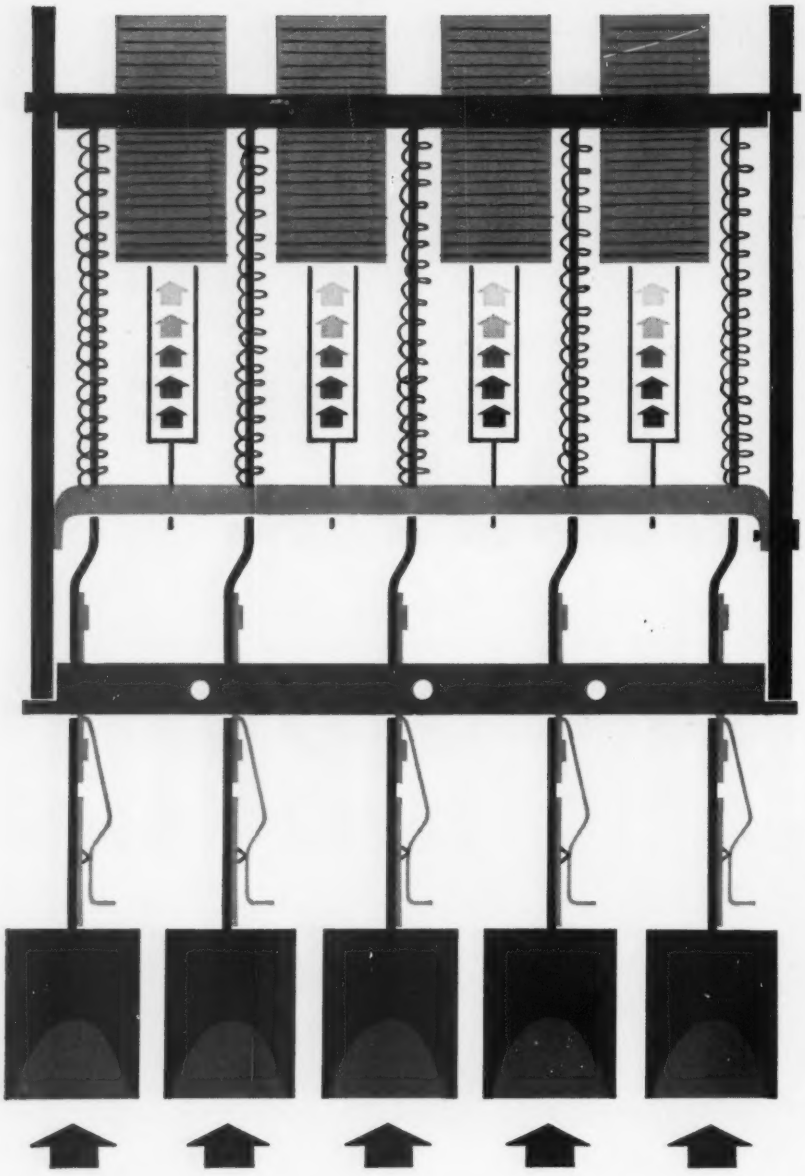
LINK-BELT

SPEED REDUCERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representat. es Throughout the World.

14.708-A

Circle 422 on Page 19



The illustration details the principal action of pushbutton radio tuner. Though each pushbutton travels the same distance "in", each positions the cores differently in relation to the tuning coils.

you call the move . . . we'll make the motion

Go right ahead, call the *move!* . . . up, down, over, under, around, right, left, in, out, one at a time, all at once . . . we'll make the *motion*, the whole motion. Your *move* will be designed and manufactured as a complete actuating package, fully tested and operation proved.

Radio Condenser *Custom-Made* Electromechanical Assemblies offer *programmed motion at a touch.* In the fast-growing field of pushbutton dynamics, for example, R/C assemblies can make a finger do most anything . . . tune a radio, "switch" TV channels, do the wash, shift gears, cook breakfast . . . you name it!

Let R/C's more than a quarter-century of electromechanical experience work for you. Make the *move* today! Write for literature.

CONTROLS DIVISION

R/C RADIO CONDENSER COMPANY CAMDEN 3, NEW JERSEY

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for closed hydraulic systems

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Rimula Oils—for heavy-duty diesel engines

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Alvania Grease—multi-purpose industrial grease

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

Its performance and name are the same around the world

Shell Dromus Oils are a quality line of soluble cutting oils that permit higher speeds and greater feeds while extending tool life. They have excellent wetting and cooling properties and are not sticky or greasy.

Dromus* Oils have the added advantage of being easy to mix in hot or cold, hard or soft water. They form emulsions which remain stable in any concentration required in the shop.

When your machine tool customers abroad specify Dromus Oil, they will enjoy the same efficient performance your domestic customers rely upon.

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

*Registered Trademark

SHELL DROMUS OILS

SHELL

Circle 424 on Page 19

KLIXON Protectors

Standard Equipment on Flint & Walling Motors

"A KLIXON *motor protector is standard specification in all single phase Flint and Walling motors. The owner of an F & W water system is assured of overload protection because his pump is powered by a Flint and Walling motor protected by a built-in* KLIXON *Protector."*

That's how Lauren D. Eckhart, Chief Engineer of Flint and Walling, producers of domestic and farm water supply equipment, sums up his feelings about KLIXON Protectors.

And Flint and Walling is one more progressive manufacturer who counts on KLIXON Protectors to produce maximum motor performance with minimum failures during periods of overload.

You, too, can get maximum overload capacity with dependable over-temperature protection in the motors that operate your equipment . . . just specify and use KLIXON Protected Motors. Write now for complete details on KLIXON Inherent Protection for single and polyphase motors.

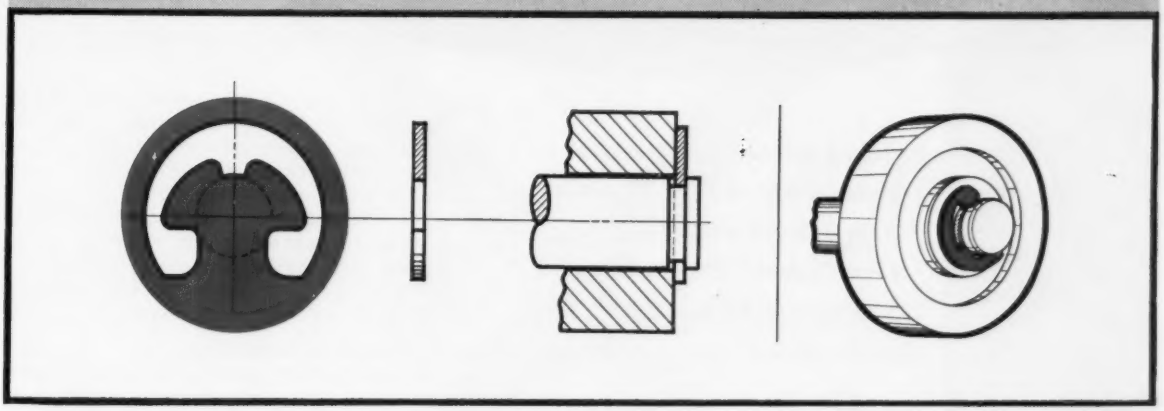
METALS & CONTROLS CORPORATION

Spencer Division 3205 Forest Street, Attleboro, Mass.

KLIXON®

Circle 425 on Page 19

New Waldes Truarc Reinforced "E-ring" Provides 5 Times More Gripping Power, 50% Higher RPM Limits Than Conventional E-Type Rings



The new Waldes Truarc Series 5144 is a radially-installed reinforced "E-ring." It is designed for use in assemblies where the ring is subject to strong push-out forces resulting from heavy vibration and shock loads, high rotational speeds or relative rotation between the retained parts.

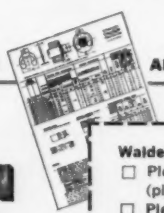
Series 5144 provides the following application advantages over conventional E-type fasteners:

1. **GREATER GRIPPING STRENGTH**—approximately five times greater than conventional "E-rings" of the same metal and thickness.
2. **HIGHER RPM LIMITS**—approximately 50% higher in most sizes.
3. **POSITIVE LOCKING IN THE GROOVE**—large corner radii or chamfers can be accommodated without separator washers.
4. **LOWER GROOVE COSTS**—because recommended groove tolerances have been increased, machining grooves for the series 5144 is less expensive.
5. **WIDER APPLICATION**—because series 5144 rings made of aluminum are stronger than conventional "E-rings" made of steel, the fastener may be used in applications where corrosion resistance or weight are factors.

Truarc Series 5144 Reinforced "E-rings" are available for shaft diameters from 3/32—7/16 in. in carbon spring steel, stainless steel, beryllium copper, aluminum, and phosphor bronze. They are available stacked on rods for high speed installation with Truarc applicating and dispensing equipment.

As in all Truarc rings, you get statistically controlled quality from engineering and raw materials to the finished product. Complete selections are available from leading OEM distributors in 90 stocking points throughout the U. S. and Canada. Design Engineering Service is available to you. Send us your blueprints. Let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES AND ENGINEERING DATA



WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Reinforced "E-rings." (please specify shaft size)_____

☐ Please send me Engineering Data Sheet

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

MD 050

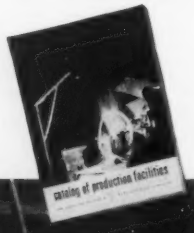
Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

Circle 426 on Page 19

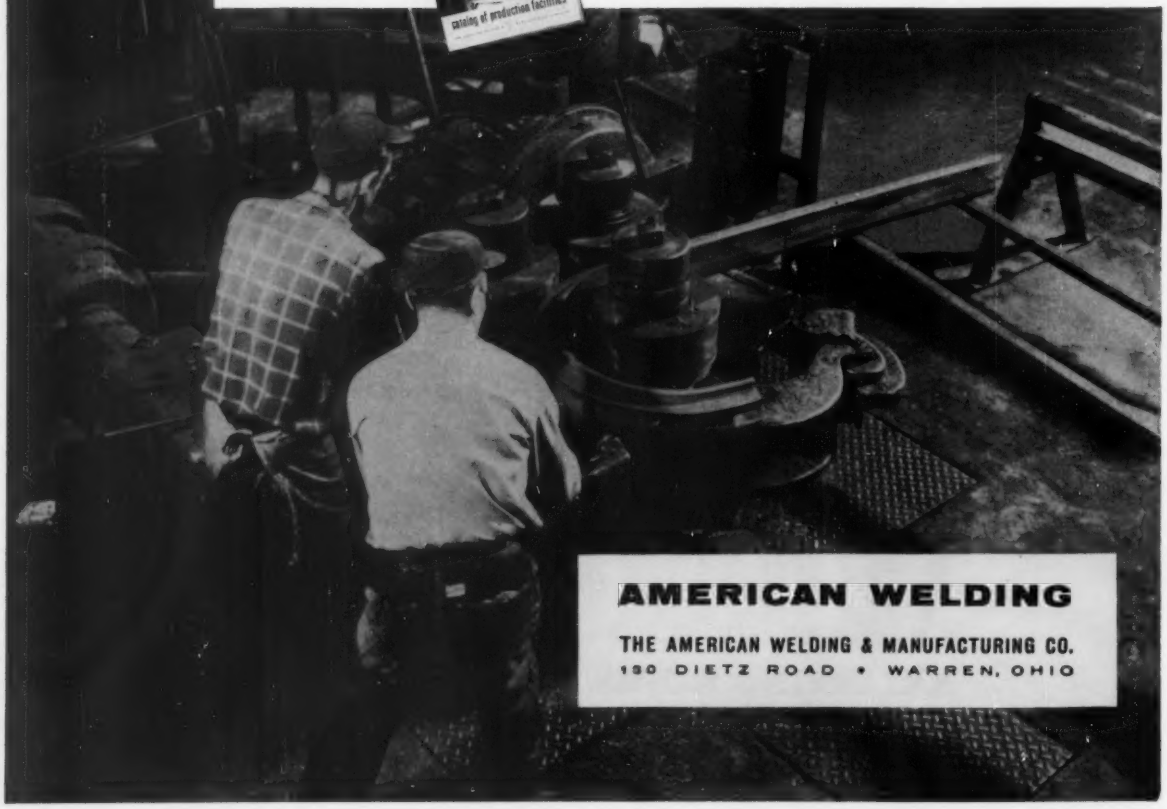
Extruded Shape Formed and Flash Butt-Welded . . . the Low-Cost Way to Make this 268 lb. Stainless Steel Ring

By using extruded or mill-rolled shapes and flash butt-welding, American Welding can frequently help customers slash production costs of their circular products over other methods of manufacture. Savings in expensive metals are substantial, plus sizable reduction in machining time. And where some of the more difficult metals to weld — such as titanium, aluminum, zirconium, stainless and heat-resistant alloys — are required, American Welding has the special knowledge and equipment to do those difficult jobs to your specifications.

The use of flash butt-welded rings, bands, and assemblies has saved millions of dollars for jet engine manufacturers . . . why not investigate what economies it can mean to you. If it's circular and of metal — call American Welding first!

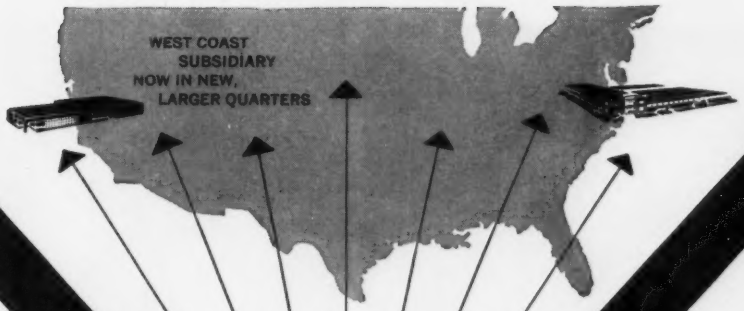


NEW PRODUCTS CATALOG AVAILABLE. Write today for 20-page catalog illustrating the many types of circular products American Welding can form, weld and machine for you.



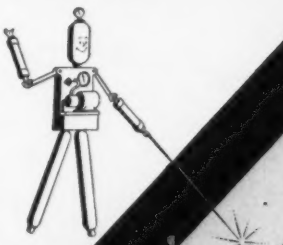
AMERICAN WELDING

THE AMERICAN WELDING & MANUFACTURING CO.
190 DIETZ ROAD • WARREN, OHIO



GREER ACCUMULATORS ...NOW NATION-WIDE SALES AND SERVICE

PROOF OF EXTRA SERVICE...



U. S. Patents under Olaer Licenses

New!

GREER PRECISION THROTTLING VALVES WITH INTERCHANGEABLE PORT FLANGES

A proven and exclusive valve line available in 6 line sizes up to 2". Greer's universal design concept provides maximum flexibility and standardization for virtually all hydraulic systems. Cuts installation, maintenance, spare parts and other costs.

Write for descriptive Greer Brochure TV-12

THE GREER NETWORK OF SALES OFFICES AND REPRESENTATIVES is now located in cities from coast-to-coast, and is expanded with the addition of a new west coast sales, service and manufacturing facility.

All Greer representatives are specialists in the field of fluid mechanics, and provide know-how and experience in the application of Greer Accumulators and hydraulic components to modern machinery and equipment. Greer distributors and sales offices carry a complete inventory of accumulators and spare parts for prompt, on-the-spot sales and service.

For immediate assistance with any hydraulic problem, your Greer representative is *the man* to contact. Call or write today without obligation.

Distributors & Representatives: **ATLANTA,** J.A. Postell • **BUFFALO,** Tri-Line Corp. • **CLEVELAND,** The Paquin Co. **DAYTON,** The Paquin Co. • **PHILADELPHIA,** The Maleson Co. • **PITTSBURGH,** Weiman Pump & Supply Co.

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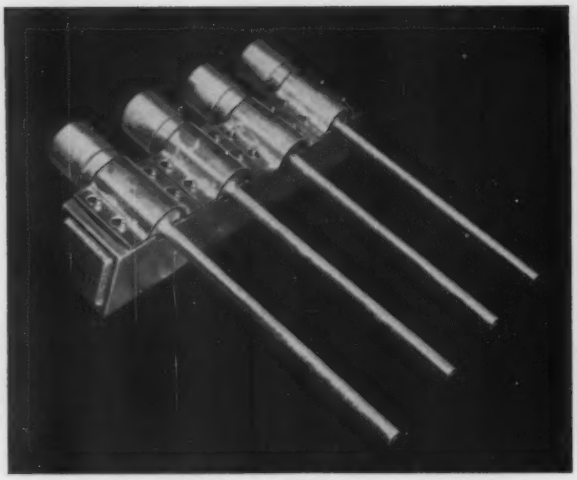
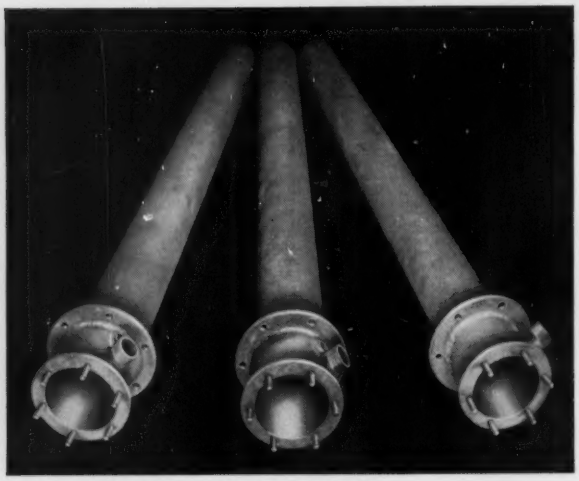
Subsidiary: **GREER HYDRAULICS ENGINEERING CORP.** • 4474 East Olympic Boulevard, Los Angeles 23, California

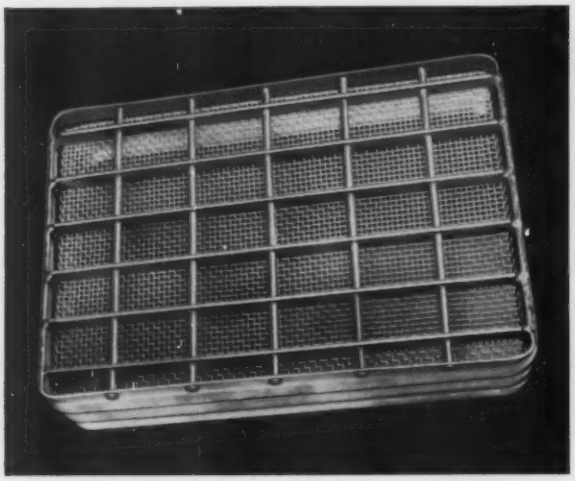
Circle 428 on Page 19



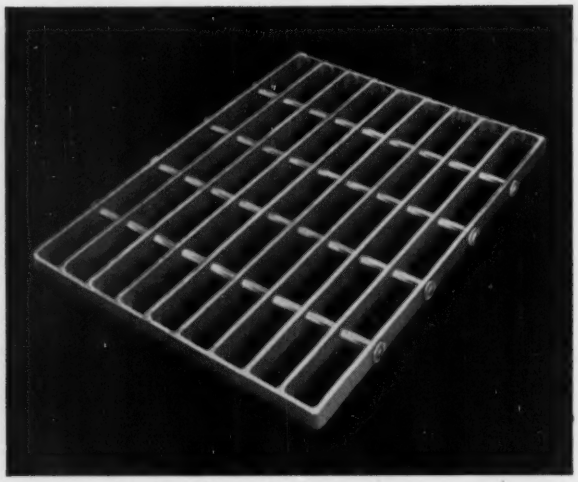
FIRING RETORT—a fuel injection unit for heat-treating processes



HEATER TUBES—for annealing steel at 1550°F



BASKET—spacer tubes for carburizing furnace



TRAY—for copper brazing at 2050°F

They stay on the "hot" jobs longer... with Carpenter Heat-Resistant Tubing

When the heat's on . . . remember, industry in many fields has been getting stainless tubing and pipe affording maximum heat and corrosion resistance for over 25 years from Carpenter.

Carpenter has an extensive background of experience and research in heat resistant alloys: Type 309S, Type 309SCb, Type 310, Type 330.

This experience is available to you whenever you need it, and it's backed by a nationwide distribution system. There's a convenient source near you . . . either a Carpenter Distributor or a Rolled Alloys, Inc. branch office. You can get plenty of help on fabrication and application problems, too.

MEMBER

Write today for technical data:
The Carpenter Steel Company,
Alloy Tube Division, Union, N.J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

more than corrosion resistance

Heat-Resistant Tubing & Pipe

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. OFF SHELF DELIVERY in a wide range of styles and capacities, with 64,000 combinations. Write for catalog SM 56-2 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

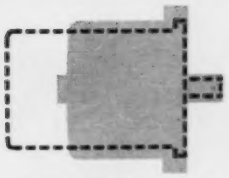
NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

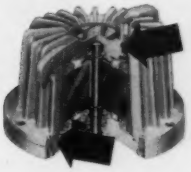
FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

Circle 430 on Page 19

Photographed underwater
at Florida's Silver Springs



1/3 SHORTER THAN EQUIVALENT
STANDARD MOTOR



SEALED FOR SUBMERGED
APPLICATIONS

New-product news from Louis Allis

Underwater is home for this motor!

New Louis Allis Immersible motor is built to operate in water, sewage, or liquid chemicals

The Immersible motor can be adapted to operate in any kind of liquid — fresh or salt water, sewage, chemicals, or abrasive industrial cutting oils. It's the ideal means to provide power in a vat or sump — at the bottom of a pool, lake, or ocean!

No matter how deep your setting, the Immersible motor provides close-coupled power — saves you the need for expensive jack-shafting, intermediate bearing supports between pump and a surface-mounted motor, and mounting structures.

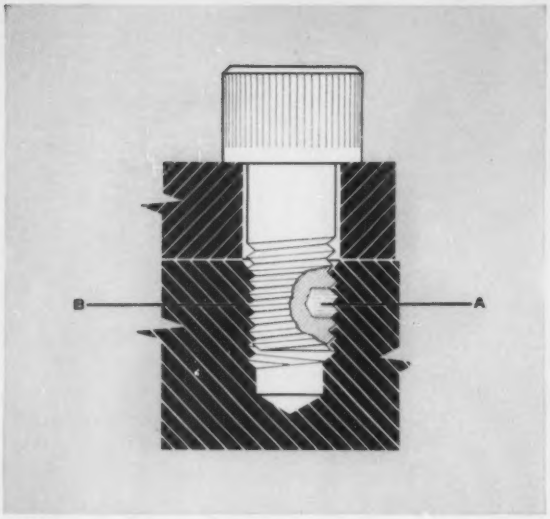
The motor is oil-filled and sealed at the factory. Diaphragm breathers equalize internal and external pressure — eliminate pressure at the shaft seal and prevent leakage. All joints are sealed to keep water and dirt out. Vinyl-coated housing and stainless or suitably plated exposed parts resist corrosion. Mating surfaces of the housing and flange are precisely machined to provide accurate alignment of the pump impeller and casing.

The Immersible, as shipped, is ready for horizontal or vertical mounting on pumps, agitators, mixers, or special equipment. Sizes range from ¾ to 40 hp. For additional information contact your local Louis Allis District Office, or write for Bulletin 2300, The Louis Allis Co., 459 East Stewart Street, Milwaukee 1, Wisconsin.

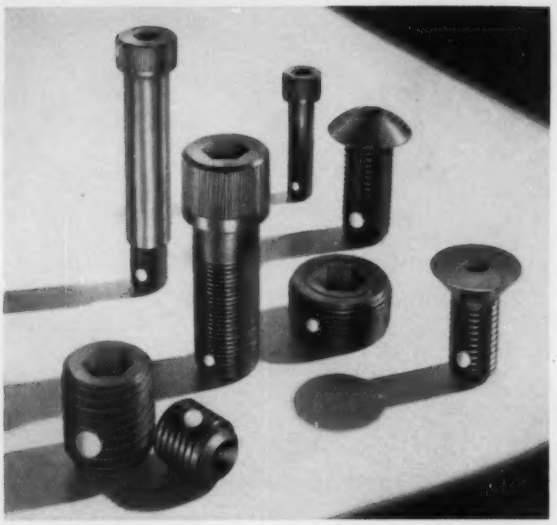
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

Circle 431 on Page 19



How Nylok Locks. Resilient nylon pellet (A) sets up lateral thrust, smoothly wedging mating threads together (B). Locking action is entirely on threads and is positive, seated or unseated. UNBRAKOS with Nylok are easy to remove and are reusable.



Self-Locking UNBRAKO Socket Screws, in a full range of standard types and sizes, are stocked by your authorized SPS distributor. Permanently installed locking pellets are serviceable from —70 to +250°F and will not dry out, rot or shrink.

Only Screws That Stay Tight Are Reliable!

Use UNBRAKO socket screws with Nylok*

to increase the reliability of your mechanical assemblies

Fastener reliability is essential not only in the products you manufacture, but also in the machinery you use. Yet 9 times out of 10, the ordinary threaded fastener will work loose if subject to impact, shock or vibration . . . and it usually is. In the case of industrial equipment, this tendency of fasteners to loosen can mean added maintenance costs, production delays, or even damage to machinery. With consumer goods, it can mean extra service calls and repairs—irritating to the customer and, more often than not, unprofitable for the manufacturer.

Past efforts to solve this problem have involved use of lockwashers, cotter pins and wiring. These conventional locking devices are not always completely reliable. Lockwashers sometimes snap or lose their spring; and with cotter pins or wiring partial loosening is likely. Furthermore, these devices take extra time and labor to install.

UNBRAKO socket screws with Nylok offer you a simple, practical solution to this problem of fastener reliability. An UNBRAKO with Nylok is a single self-locking unit—requires no auxiliary fastening elements. The tough, resilient nylon pellet—permanently installed—forces mating threads tightly together, locking the screw securely, seated or not, wherever wrenching stops. It will not work loose, despite severe vibration.

Off the shelf, a self-locking UNBRAKO may cost you slightly more than an ordinary screw. But f.o.b. your product, it usually costs less . . . assembly time, labor and reliability considered. See your authorized SPS distributor for complete details. Or write us for literature and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

hiRf High Reliability factor

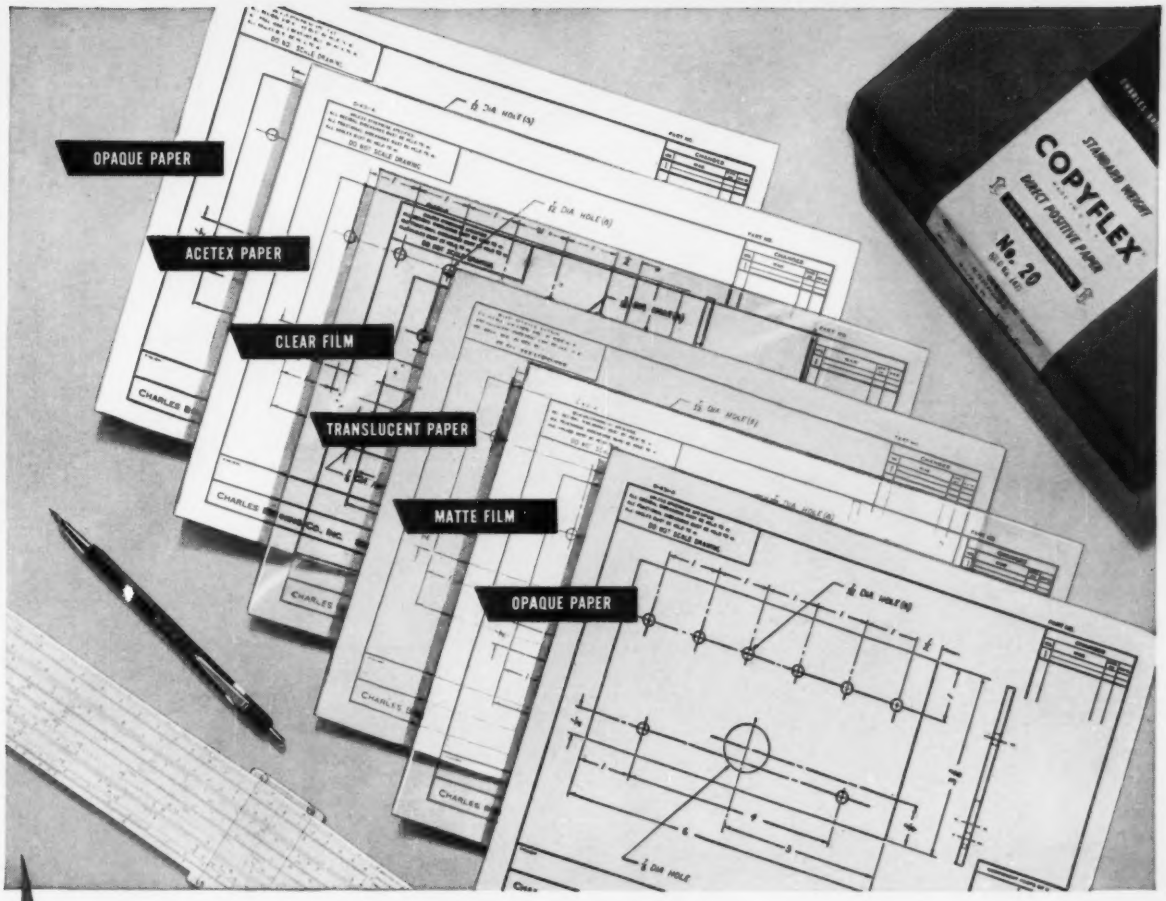
At SPS we apply a dynamic standard of quality—continually refined—so that our fasteners will always have the high reliability factor required by today's faster speeds and greater dynamic stresses. By using SPS fasteners in your assemblies, you help increase overall reliability—the certainty of predictable performance under actual service conditions.

For more information on the full meaning of reliability, write for a copy of the new SPS booklet "Concerning High Reliability."

We also manufacture precision titanium fasteners / write for free booklet

SPS **Jenkintown • Pennsylvania**

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.



Here's Colorful Versatility in Reproduction Materials!

The utility of any reproduction machine depends greatly on the variety and quality of materials available for making prints. Shown above are a few in the complete line of Bruning Copyflex Sensitized Reproduction Materials. Copyflex materials work together with Copyflex reproduction machines to give you faster, better, more versatile reproduction.

BRUNING SENSITIZED OPAQUE MATERIALS.

Copyflex Papers come in three weights of white and a variety of tints. Different Copyflex developing solutions produce different color images, permit many color combinations. You can get papers coated on both sides for two-sided printing.

Cardstocks are available in three weights, in white and variety of tints. Tints are useful for indicating design alterations, identifying different filing periods, and color-coding the distribution of prints.

Acetate Coated (Acetex) Papers are white or aluminum color. Smooth, glossy, surfaces are eye-appealing, washable and durable. Brilliant, dense color images can be produced with different Copyflex developers.

Copyflex Opaque Cloths are tough, durable, and provide highly workable surfaces for alterations with pencil or ink. Ideal for maps, plats, charts, and plans.

BRUNING SENSITIZED TRANSLUCENT MATERIALS.

Here are the famous Copyflex intermediates with which you can make reproducible prints of originals to save up to 90% in tracing time in re-working originals.

Copyflex Papers are resin-transparentized sensitized mediums that provide a positive, reproducible image of all or any selected part of an original, a workable drawing surface for making design additions or alterations.

Copyflex Cloths make strong, permanent, and water-repellent "duplicate originals." Twin matte surfaces permit pencil or ink alterations to be made on either side.

Copyflex Acetate Films with matte finish or clear finish provide durable, waterproof, highly reproducible prints. Ideal for making design changes and composite prints. Different Copyflex developers can be used to produce brilliant colors for visual aid applications.

No other combination of reproduction materials and reproduction machines offers you so many ways to save time and money as does Copyflex. Get full information by mailing the coupon below.

BRUNING *Copyflex*

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Please send me the free booklet on Copyflex machines and materials.

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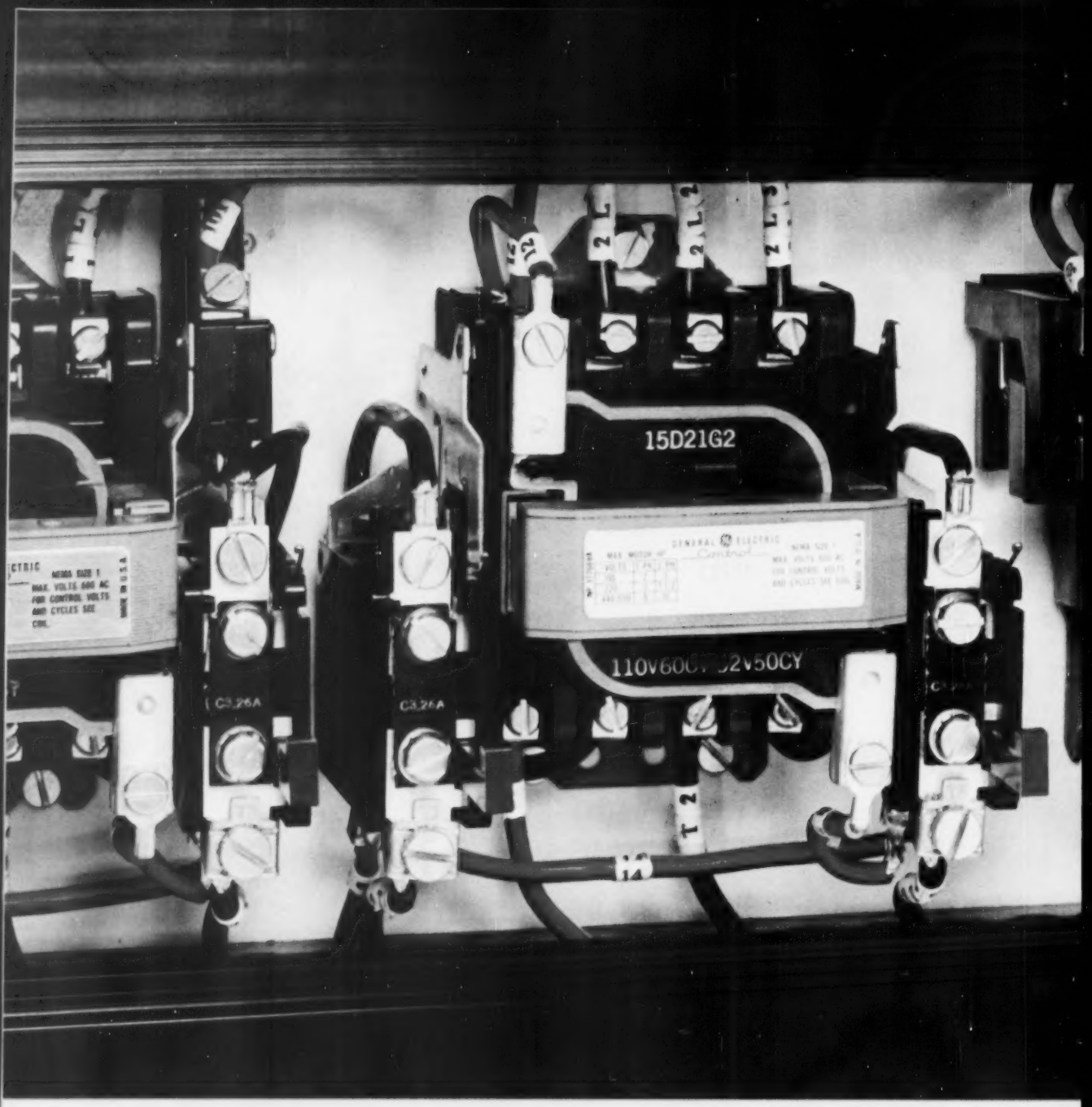
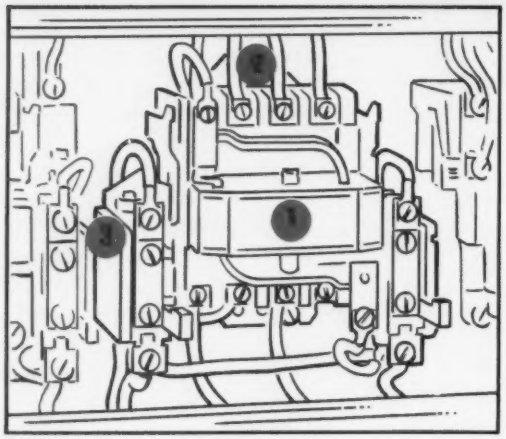
Circle 433 on Page 19

Circle 434 on Page 19→





1. **42% SMALLER SIZE.** The new 100-Line General Electric magnetic starters (Size 0 and 1) are only as high as G-E 4- and 6-pole relays. You no longer waste space on your panels.

2. **STRAIGHT-THROUGH WIRING.** All you do is insert your leads into the pressure-type terminals and tighten. They are on the front of the new G-E magnetic starter — easy to reach.

3. **ADJUSTABLE OVERLOADS.** A new finger-tip adjustment of the overload relay trip setting allows easy adjustment between plus or minus 15% of the nominal heater rating.

NEW G-E SIZE 0 AND 1 MAGNETIC STARTERS

Cut cost by reducing panel space and assembly time

BECAUSE THEY'RE 42% SMALLER — FEATURE STRAIGHT-THROUGH WIRING, FRONT CONNECTIONS

These new, radically different 100-Line General Electric magnetic starters have been designed to help you save panel space and assembly time.

SAVE PANEL SPACE. The new starter is 42% smaller — now approximately the same height as G-E 4- and 6-pole relays. When starters and relays are mounted side by side, you no longer waste space below the relays. G.E.'s straight-through wiring and cooler operation mean you need only ½ inch on each side of the new starter. The coil inrush current has been reduced so you can use a 40 volt-amp control transformer. You also have your choice of vertical or horizontal mechanical interlocking on reversing starters. The savings in panel space also help meet the new JIC specifications.

SAVE ASSEMBLY TIME. The new, 50% lighter weight G-E magnetic starter is fast and simple to install and connect. Straight-through wiring means you attach leads to the terminals at the top and bottom of the starter — no more run-a-round wiring to take extra time and space. You mount the starter by simply sliding its key holes over three mounting screws on the panel. This new General Electric magnetic starter will easily cut your assembly time.

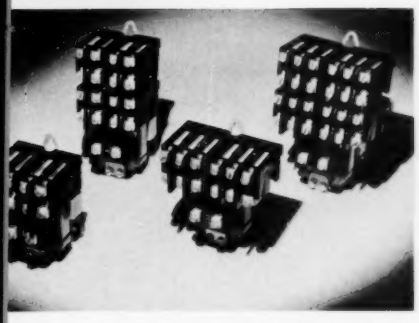
Your customers will enjoy extremely quiet, dependable operation — and appreciate the fast inspection and the 20-second disassembly, made possible by "snap-slide" construction. They'll also like the space savings your smaller, more compact panels provide.

Like more information? Contact your nearby General Electric Apparatus Sales Office, or write to Section 731-15, General Electric Co., Schenectady, N. Y., and ask for bulletin GEA-6611.

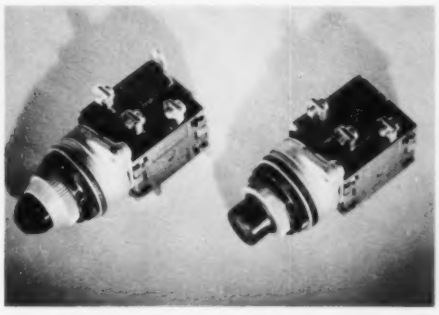
General-Purpose Control Dept., Bloomington, Ill.

Progress Is Our Most Important Product

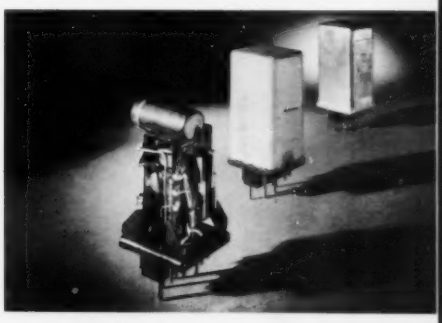
GENERAL ELECTRIC



MACHINE TOOL RELAYS have front connected terminals, are easy-to-wire from four directions, and are also available in latched-in forms.

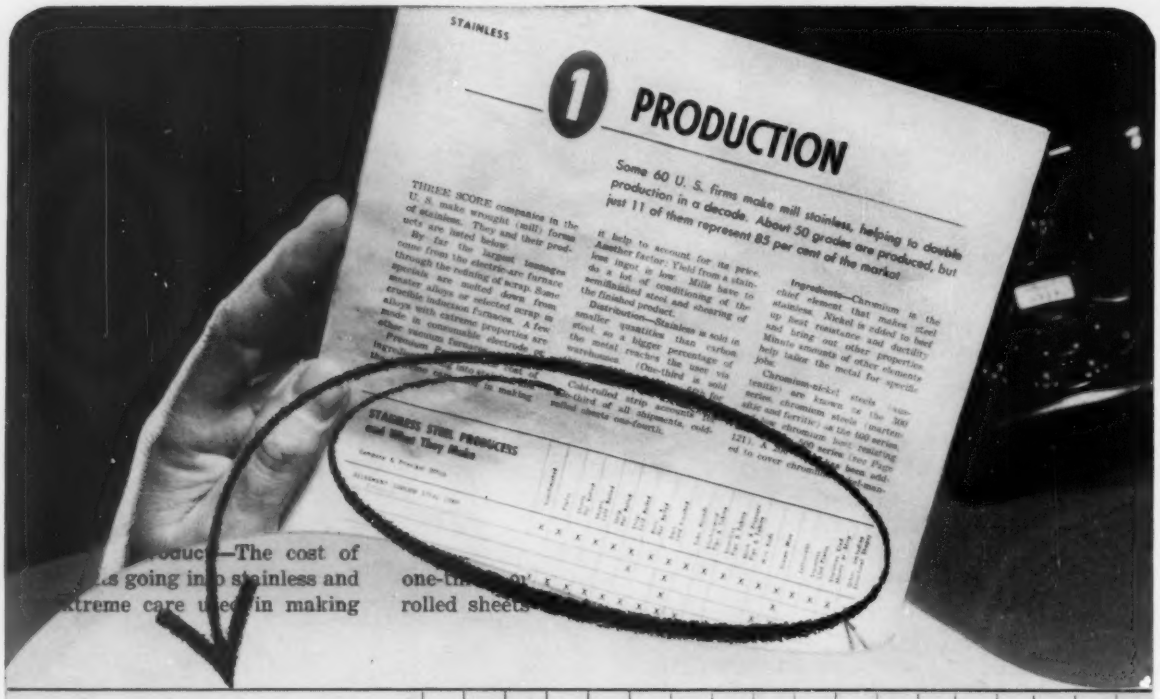


OIL-TIGHT PUSH BUTTON UNITS. The new push to test unit checks for burned out bulbs — the new illuminated unit reduces panel space 50%.



STATIC CONTROL components, in easy-to-use plug-in form, provide reliability for critical jobs. Photo shows three steps of encapsulation.

Experience**—the added alloy in **A-L Stainless, Electrical and Tool Steels


STAINLESS
1 PRODUCTION
Some 60 U. S. firms make mill stainless, helping to double production in a decade. About 50 grades are produced, but just 11 of them represent 85 per cent of the market
THREE SCORE companies in the U. S. make wrought (mill) forms of stainless. They and their products are listed below.
By far the largest tonnages come from the electric-arc furnace through the refining of scrap. Some specials are melted down from master alloys or selected scrap in crucible induction furnaces. A few alloys with extreme properties are made in commercial electrode furnaces in vacuum. Finishing
Ingredients—Chromium is the chief element that makes steel stainless. Nickel is added to beef up heat resistance and ductility and bring out other properties. Minute amounts of other elements help tailor the metal for specific jobs.
Chromium-nickel steels (austenitic) are known as the 300 series. chromium steels (martensitic and ferritic) as the 400 series.
STAINLESS STEEL PRODUCERS and What They Make
—The cost of ...s going into stainless and ...treme care used in making
one-third of ... rolled sheets

STAINLESS STEEL PRODUCERS and What They Make Company & Principal Office	Semifinished	Plates	Sheets, Hot Rolled	Sheets, Cold Rolled	Strip, Hot Rolled	Strip, Cold Rolled	Bars, Hot Rolled	Bars, Cold Finished	Tube Rounds	Electricweld Pipe & Tubing	Seamless Pipe & Tubing	Mech. & Pressure Pipe & Tubing	Wire Rods	Drawn Wire	Extrusions	Stainless Clad Plates	Stainless Clad Sheets or Strip	Other, Including Structural Shapes
ALLEGHENY LUDLUM STEEL CORP. Pittsburgh	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
[illegible]						X		X						X				

Of the 60 producers of stainless steel...

only ALLEGHENY LUDLUM makes all sizes, shapes, finishes and analyses

In its November 4, 1957 issue, STEEL magazine published a complete run-down on the stainless steel industry. This article reveals that *only Allegheny Ludlum*, of the 60 some companies making stainless, produces all sizes, shapes, finishes and analyses.

This can save you considerable time and money. When you make Allegheny Ludlum your *one* source of stainless, you work with *one* sales engineer—*one* order, whether you buy sheet, strip, bars, tubing or whatever.

And, at the same time, you get the best technical service. A-L's crack research and development department is continually searching for new alloys, and better ways to use today's. Its findings are freely available to you through sales engineers, technicians and special literature.

Allegheny Ludlum follows the product from the melt through to finished form, has greater quality control over the stainless you buy. And since A-L makes all forms of stainless, you get unbiased recommendations as to what is best for your individual needs.

Profit by Allegheny Ludlum's status as the only one-source integrated supplier of all stainless forms. Call your A-L representative today . . . see how he can save you money and time. Or write ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

WBW 7121

ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . . EVERY HELP IN USING IT

Problem:

"Surface of two parts to be joined must be flush. High fastening torque is required, so maximum head contact and high tensile strength is a must. Fastener must be removable . . ."

Solution:

HOLO-KROME FLAT HEAD CAP SCREWS. Made of special analysis alloy steel heat-treated to 38-42 Rockwell "C" hardness. Sockets are scientifically proportioned for highest strength and trouble-free driving. Internal hex socket drive assures a smooth, unmarred head. New forging methods result in improved fiber flow, tougher screws. Threads are Unified Class 3A fit.

For the finest in Hex Socket Screws . . . for unmatched Same-Day Service, the name to remember is Holo-Krome.

HOLO-KROME SOCKET SCREWS

THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.

SOLD ONLY THROUGH AUTHORIZED HOLO-KROME DISTRIBUTORS

Wear Resistance is a common problem for designers, even when they're using a durable material like steel. Of course, it is well known that you can increase the abrasion resistance of a given steel when you improve its hardness (and thus, its strength). But when you harden and strengthen a steel so that it will resist wear, you usually run into some complications.

For instance, when we vary the wear resistance of steel, we also vary its *other* properties, and this causes problems for the designer or his metallurgical advisor. Examples: hardness and strength can be developed in various ways—increase the carbon content, add alloying elements, cold work, heat treat. These methods vary in cost, and each has a different effect on hardness, strength, toughness, corrosion resistance, formability and weldability.

There is one steel with the best combination of properties for every design application, and you're almost sure to find it in the vast range of USS Design Steels—whether Carbon, High Strength, Alloy or Stainless Steel. Here is the widest range of steels available, offered by a company that has produced well over a *billion* tons of steel.

Of course, over-design must be avoided as rigorously as under-design, and designers must always walk the prickly path between poor product performance on one hand and high costs on the other. Somewhere among the many USS Design Steels there is the one best steel for the job. The final selection can best be made with the help of a skilled metallurgist—either on your staff or ours.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS TRADEMARK United States Steel

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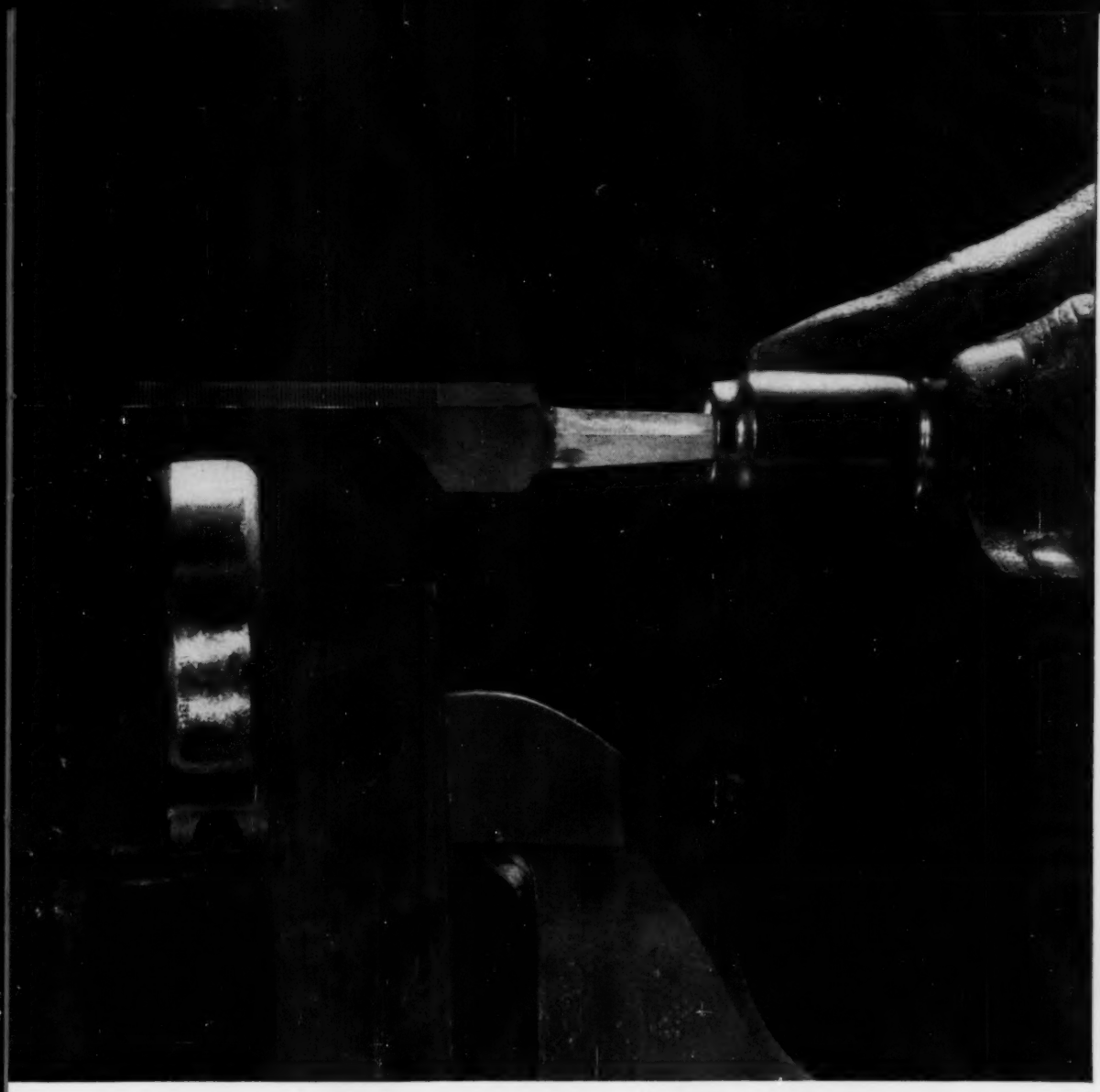
STEELS FOR DESIGN

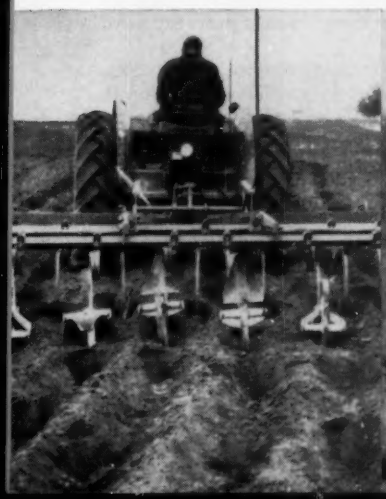


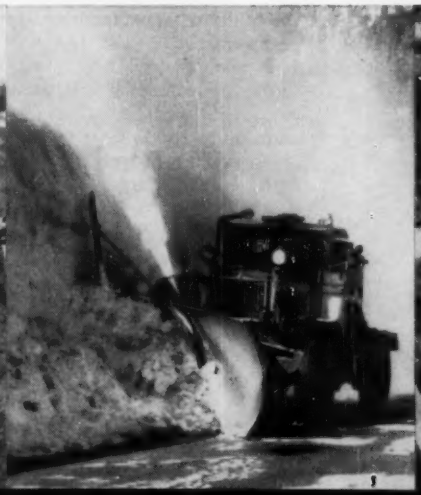
Lower Left—Problem: Blades on this earth dammer wore out after 300 acres. Solution: Blades are now made from USS MAN-TEN Steel, one of several USS HIGH STRENGTH STEELS. Benefit: Blades now last over 1,000 acres for Gunning Mfg. Co., Lansford, N. D.

Lower Middle—Problem. The new "Snow Hawg" rotary snow plow chews into ice, rock and frozen earth and throws it up to 300 feet. A weldable, very strong steel was needed to withstand the punishment. Solution: Vital parts are made from USS "T-1" Constructional Alloy Steel. It can be field-welded, and remains strong and tough down to minus 50°F. Benefit: Outstanding performance, and chute liners of the "Snow Hawg" last two to three times longer.

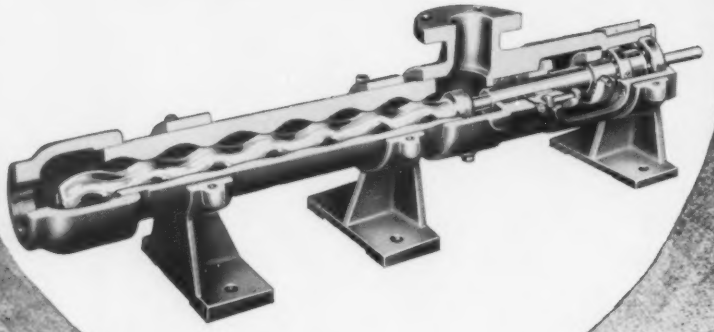
Lower Right—Problem: Chutes in a coal processing plant wore out prematurely due to abrasive action of coal and corrosion from acid water. Solution: Chutes made from USS Stainless Steel were installed. Benefit: New chutes outlast old ones seven to one. Atkins Coal Company, Frackville, Pa., estimates that a $900 investment in Stainless Steel chutes saved $30,000.

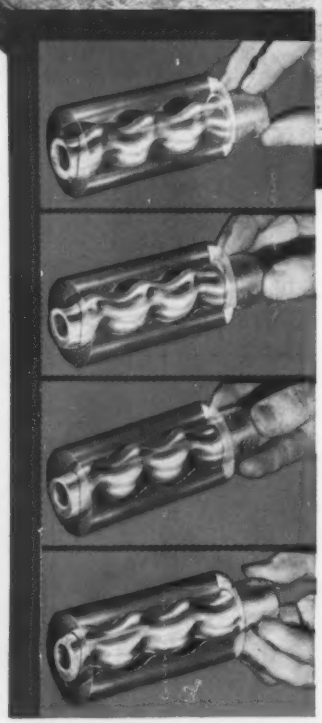
USS, MAN-TEN and "T-1" are registered trademarks of United States Steel





IF IT CAN BE PUSHED THROUGH A PIPE... A MOYNO® WILL PUMP IT!





Moyno's exclusive "progressing cavity" principle permits hundreds of formerly "unpumpable" materials to be handled successfully. The screw-like rotor revolves in a double threaded stator forming "progressing cavities" that move the material smoothly without foaming, aerating, crushing or excessive pump wear.

Typical materials pumped include non-pourable pastes, slurries, chemicals, foods, acids, even suspended solids up to one inch in size. Capacities available up to 500 gpm and pressures up to 1000 psi.

No doubt a Moyno Pump can cut costs drastically for you. *Write for Bulletin 30-MD.*

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

MOTORS FANS HOISTS MOYNO PUMPS INDUSTRIAL PROPELLAIR FANS

Circle 438 on Page 19

News about HYPALON®

Seals of HYPALON in heat exchanger are undamaged by 125° F. aqua regia fumes

J. Bishop & Co. Platinum Works, refiners of precious metals at Malvern, Pa., have installed a new shell-and-tube heat exchanger to condense aqua regia fumes for safe disposal. The exchanger contains 1,275 Pyrex tubes each ⅜ in. diameter and 10 ft. long. Water circulates through the tubes; the aqua regia fumes are on the shell side.

Nearly 4,000 plugs of HYPALON, resembling one-hole bottle stoppers, are used to seal the tubes in the tube sheets—one seal per tube at the top tube sheet, two at the bottom. The seals of HYPALON permit thermal expansion and contraction; they prevent intermingling of fumes and water and they withstand aqua regia fumes at 125° F. The seals of HYPALON have been used for over 13 months without a failure.

HYPALON is especially suited for service where conditions are extreme. In addition to chemical resistance, this newest Du Pont synthetic rubber is completely resistant to ozone and highly resistant to heat, abrasion, weathering and flex cracking. Seals, gaskets, tank linings are but a few applications. Send coupon for details.

Seals of HYPALON resist corrosive action of hot aqua regia. 3,825 seals are used in this heat exchanger.

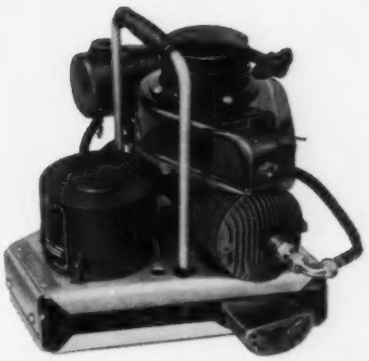
HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

Neoprene shock absorbers replace flywheel in flyweight generator

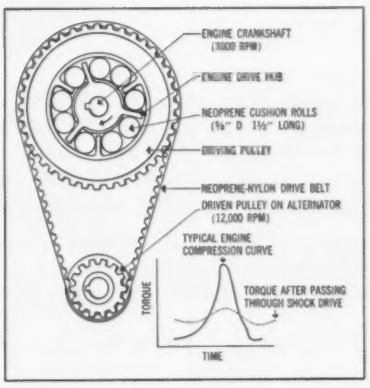
Neoprene was chosen by Lear, Inc., of Santa Monica, Calif., in the design of a portable 1500 watt engine-generator set that weighs only 35 lbs. It consists of a 1200 rpm permanent-magnet generator driven by a toothed belt from a 400 rpm one-cylinder two-cycle engine.

There is no flywheel. It was eliminated to save weight. Instead, Lear engineers have interposed nine cylindrical neoprene cushions in the power train between the engine crankshaft and the drive pulley (see drawing). The cushions iron out torque surges inherent in a one-cylinder engine.

Engine pulsations rapidly wore out drive belts in an early experimental model built without flywheel or cushions. Now, models with neoprene shock absorbers get good service life from drive belts. (Belts are neoprene reinforced with nylon, toothed to maintain a strict 3-to-1 ratio between generator and engine.)



Use of neoprene cushions instead of heavy flywheel cuts weight of this portable 1500 watt generator to 35 lbs.



Neoprene was chosen for both the belt and cushions because it is the only rubber that resists both oil and ozone at once. In addition, neoprene's resistance to heat, abrasion, chemicals, grease and weather gives you an outstanding combination of properties for designs that call for a durable resilient material. Please mail coupon for more information.

ELASTOMERS IN ACTION HYPALON® • NEOPRENE

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

☐ I am particularly interested in _____

☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene and HYPALON).

☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on uses of Du Pont elastomers in industry).

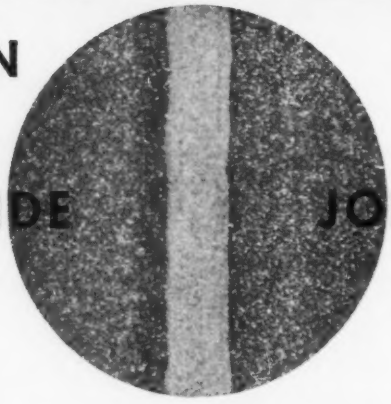
E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. MD-5
Wilmington 98, Delaware

Name _____
Firm _____
Address _____
City _____ State _____

Circle 439 on Page 19

Paul Henry uses a boroscope to inspect the magnified image of the weld seam.

INSPECTION WITH US IS AN INSIDE JOB



Damascus checks the inside as well as the outside of every piece of stainless steel pipe and tubing. With the help of a boroscope, the weld seam is examined along its full length. Skilled inspectors sort out faulty tubes . . . eliminate possible failures. The Damascus stamp of approval is your assurance of a sound product, carefully selected to fill your order.

For prompt mill shipments of stainless steel pipe and tubing in a wide range of sizes and A.I.S.I. analyses, call Damascus direct — for local service call your nearest STEEL SERVICE CENTER.

AMERICAN STEEL WAREHOUSE ASS'N

Write for free catalog.

DAMASCUS TUBE COMPANY

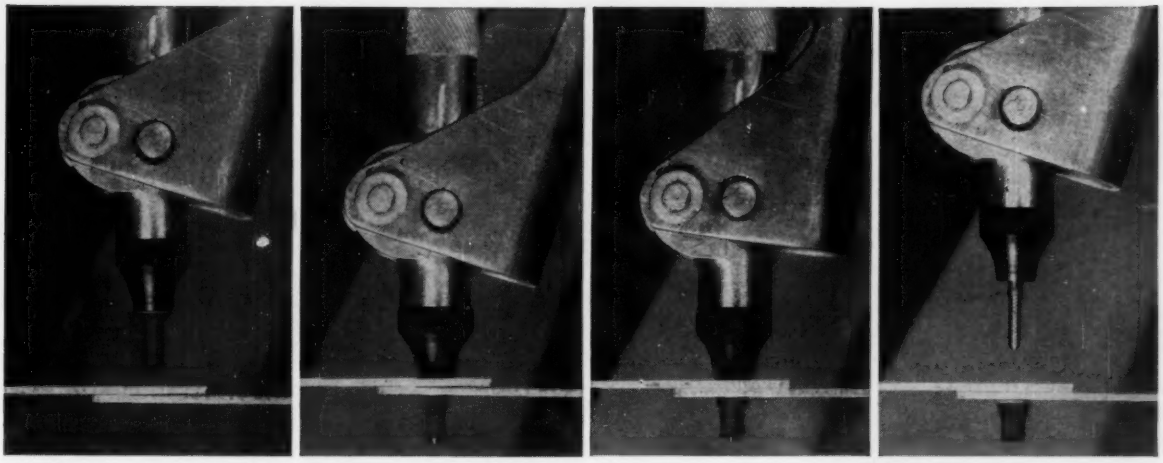
STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

FORMED STEEL TUBE INSTITUTE

B.F.Goodrich

Rivnuts® fasten thin metal... provide 6 threads in 6 seconds

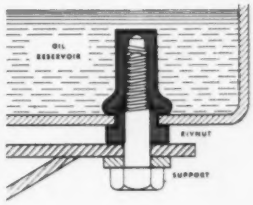


1 Rivnut is threaded onto pull-up stud of heading tool.

2 Rivnut is inserted—head held firmly against work.

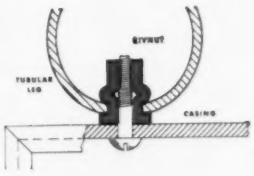
3 Tool lever operates pull-up stud, forms bulge in Rivnut.

4 After upset, Rivnut threads are ready for screw attachments.



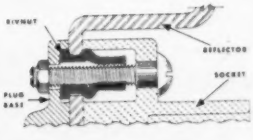
REPLACES BRAZED NUT PLATE

Rivnuts with closed ends are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated, and spacer head assures proper positioning of tank on support bracket.



ELIMINATES NUTS AND BOLTS

One worker installs a Rivnut in the tubular leg of a portable barbecue in seconds—provides a firm, accurate nut plate for screw attachment. There are no boltheads to detract from the unit's clean lines. Time is saved, too, in faster knockdown for shipping.



DOES 2 FASTENING JOBS

Rivnuts provide 6-thread nut plate for attachment from either end—or both. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket. Plug base is attached on other side. Result: fewer operations, lower assembly cost.

B. F. Goodrich Rivnuts—the easy way to cut assembly time . . . costs

Rivnuts, the only one-piece blind fasteners with threads, can be installed by one person from one side of the work—in seconds. Easy installation saves up to 50% of assembly time, reduces production costs. Rivnuts can also improve the appearance of your products and make them easier to use and service.

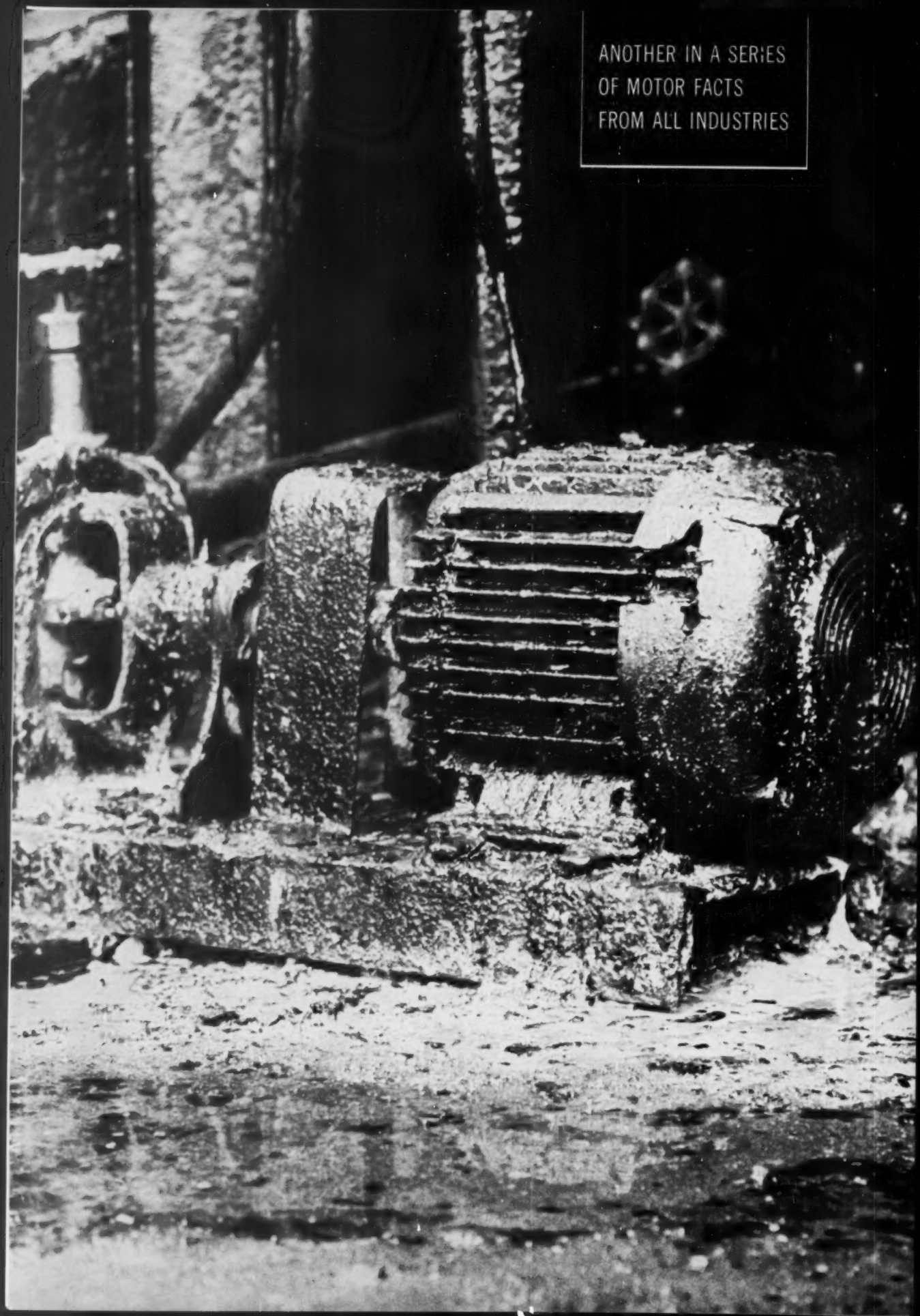
Rivnuts are made in a variety of sizes and head styles to solve almost any fastening problem. They make tight, dependable seals that resist vibration, stay put so you can assemble and disassemble the product as often as you like without stripping the threads. Welding, tapping and thread cleaning are eliminated. And you can install Rivnuts after enameling without fear of chipping.

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Department MD-58A, Akron, Ohio.

B.F.Goodrich aviation products


ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

Westinghouse motors double normal life for this application

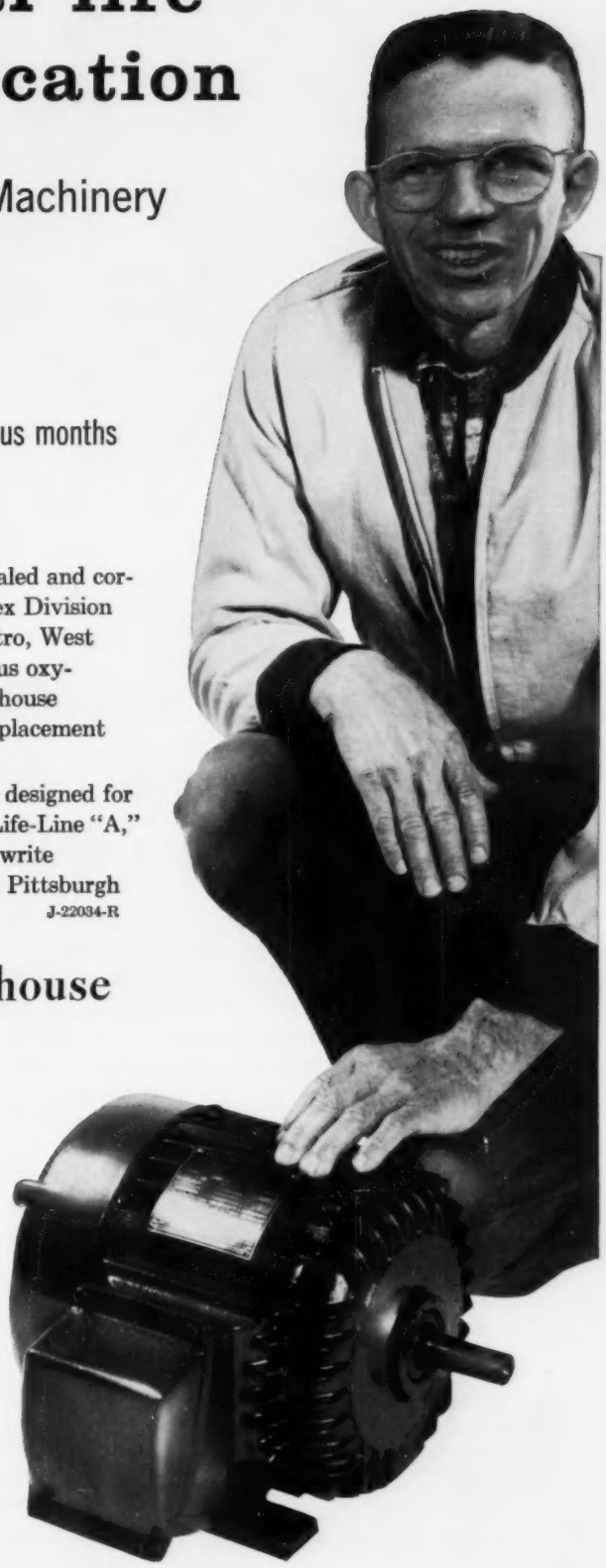
. . . at Ohio-Apex Div., Food Machinery and Chemical Corp.

this standard Life-Line "A" motor
still pumping corrosive POC I_3 after 12 continuous months
without maintenance or down time

"We must have a dependable motor, completely sealed and corrosion-resistant," says Mr. Burton Fitch, Ohio-Apex Division of Food Machinery and Chemical Corporation, Nitro, West Virginia. "A corrosive atmosphere, plus phosphorous oxychloride drip and seepage, cuts motor life. Westinghouse Life-Line® "A" motors have already passed this replacement point twice . . . and are still going strong."

Westinghouse motors last longer because they're designed for modern industry's needs. For more facts about the Life-Line "A," call your local Westinghouse representative . . . or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-22034-R

YOU CAN BE SURE... IF IT'S Westinghouse



←

Unretouched photo of Life-Line "A" three-hp motor driving chemical pump at 1730 rpm, 100 gpm at Ohio-Apex.

"Westinghouse Life-Line "A" motors have cut our motor costs substantially . . . helped us keep our chemicals moving down the line," says Mr. Fitch of Ohio-Apex. "Their built-in ruggedness, plus foolproof sealing against corrosion, means longer life, lower maintenance."

Circle 442 on Page 19

IT PAYS TO STANDARDIZE ON **STANSCREW**

Stanscrew service helps insure quality for new Tuthill pump

Marvin Williams, Works Manager, Tuthill Pump Company, says: "Dependable, precision-built fasteners are an essential ingredient of the quality we build into Tuthill Pumps.

"Therefore, when we designed our new series of high pressure Powermax pumps, we had our distributor arrange for a visit from Stanscrew's fastener specialist. The socket head cap screws he recommended for this demanding application met the stringent standards we have established. And because of our years of experience with Stanscrew, we know we can count on precise product uniformity and fast service."

Hundreds of other leading companies in American industry have also learned that it pays to standardize on Stanscrew. For Stanscrew offers a comprehensive line of over 4,000 different types and sizes of standard fasteners . . . including a complete selection of socket, set, and cap screws. These are produced in three modern plants by fastener specialists with over 85 years of specialized experience. All 4,000 items are always in stock . . . quickly available.

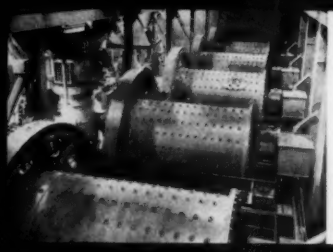
When you have a fastener problem, call your Stanscrew distributor. He will arrange for a prompt visit from the Stanscrew fastener specialist. The specific recommendations he will make can often mean important savings.

STANSCREW FASTENERS

CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT
WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

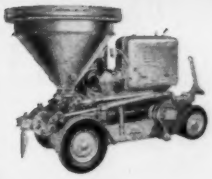
STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois

Circle 443 on Page 19



ALLIS-CHALMERS

TSP spur gears, spur pinions on Vibrating Screens and Ball Mills



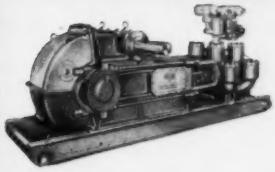
CHAIN BELT

TSP hardened products on Pumpcrete Cylinders

GENERAL AMERICAN

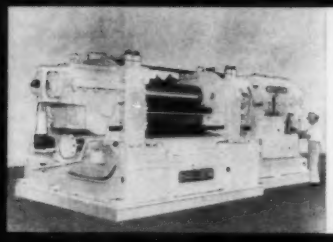
TSP trunnion rollers on Dryers

Why do these equipment builders use TSP hardened products?



WHELAND

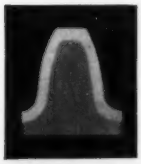
TSP gears and pinions on Slush Pumps



HALLDEN

TSP gears, pinions, racks on Flying Shears

"Tool Steel Process" hardened products when used as components, virtually eliminate replacement problems. Fewer replacement expenses, maintenance savings, reductions in costly "downtime" mean greater customer satisfaction. That's why Allis-Chalmers Manufacturing Company, Chain Belt Company, General American Transportation Corporation, The Wheland Company and The Hallden Machine Company and many more use TSP hardened products to increase the over-all quality and life of their equipment. Here are a few reasons why TSP hardened products are so desirable. They are phenomenally long wearing, a result of our special hardening process. The file hard surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. Note even depth of hardness of gear tooth cross section.



TSP hardened products are made to order from your blue prints or to fit existing equipment. They include gears, pinions, track wheels, sheave wheels, axles, rolls, bushings, liners, sprockets, screw down screws and nuts, shafts, drive clutches, trunnions, hoist drums and many others. Gears are made in sizes to 90" diameter. Other products up to 22,500 lbs. They are guaranteed in writing to outlast, out-perform any competitive part in the same service.

Write for free Bulletin 352, "Why Are They Called TSP Products"

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U.S.A.

AD 1032

The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

Circle 444 on Page 19

connect with CANNON PLUGS

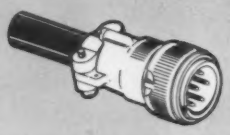
for better electrical and electronic equipment

USE for AIRCRAFT and ELECTRONIC INSTRUMENTS

TYPICAL DESIGNS

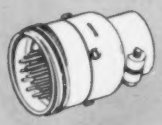
MS, MS-A, MS-B, MS-C ... Conforming to Specification MIL-C-5015C. 15 insert diameters and 260 contact layouts. 6 shell styles, MS3100 to MS3108 with all accessories. Also (MS) F.

for VIBRATION RESISTANCE and MOISTURE-PROOF applications



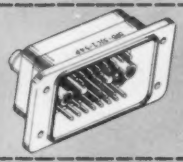
MS-E SERIES ... environment resisting. Meets Specification MIL-C-5015C. Resilient inserts. Integral cable clamp. New grounding lugs. Interfacial sealing, improved grommet and new grommet follower.

for GENERAL CIRCUITRY and QUICK DISCONNECT in more rugged applications



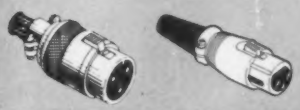
K, RK SERIES ... SPECIAL ACME THREAD. The All-Purpose Series. Conduit and cable clamp entry types. 1 to 82 contacts in 213 different contact layouts. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells.

for UNIT-PLUG-IN applications ...



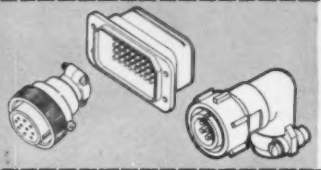
DP, DPB, DPD, DPD2, DPD2R, DPJ, AND DPS SERIES ... Rack/panel/chassis. With and without shells; coaxial and high voltage contacts. Permit quick disconnect, interchange, replacement, testing and inspection of assemblies and sub-assemblies.

for AUDIO and LOW LEVEL circuits



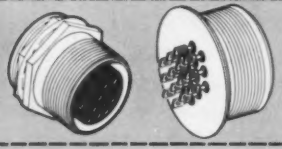
P, XLR, XL, XK, O, UA, BRS SERIES ... many shell styles and insert layouts. Straight and angle 90° plugs. Latch-lock types. Wall-mounting, panel, locknut mounting, and adapter receptacles, single- and two-gang. 10- to 30-amp. contacts, coaxials. UA Series features 3 gold-plated contacts.

for RADIO and SUB-MINIATURE applications



D, MC, DPA, DPX, AND K MINIATURES ... miniatures and sub-miniatures designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, small pre-amps, and general instrumentation where space is limited and current requirements are generally not over 5 amperes. Variety of shell styles, junction shell, and insert arrangements. 3 to 50 contacts, plus coaxials.

for HERMETICALLY SEALED applications

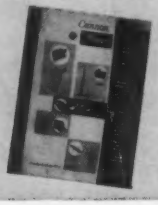


GS (MS TYPE), KH, RKH, DAH, BFH, TBFH, DBH, KH30 ... with steel shells and contacts to withstand high pressures from within or without. Insulation is a glass material, fused under high temperature to shell and contacts, thus forming a hermetic seal.

for HIGH TEMPERATURE and firewall applications

MS-K, MS-"FW," AND CANNON K-"FW" STEEL SHELL CONNECTORS ... Open flame protection offered in the greatest variety of this type of connector. Wall- or box-mounting receptacles. Straight or angle 90° plugs. Crimp-type contacts. Inserts of glass-filled materials.

Send for AR Condensed Catalog containing illustrations and technical information on all principal series of connectors in the extensive Cannon Line.



CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, Can., London, Eng., Melbourne, Austl. Manufacturing licensees Paris, Tokyo. Representatives and distributors in all principal cities.

please refer to Dept. 185

CANNON ELECTRIC

Since 1915

At The Ford Motor Company's Cleveland Engine Plant No. 1

AMERICAN BROACH & MACHINE DIVISION
BARNES DRILL COMPANY
BUHR MACHINE TOOL COMPANY
THE CROSS COMPANY
EX-CELL-O CORPORATION
EXPERT WELDING MACHINE CO.
THE FOOTE-BURT COMPANY
GREENLEE BROS. & CO.
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THE INGERSOLL MILLING MACHINE COMPANY
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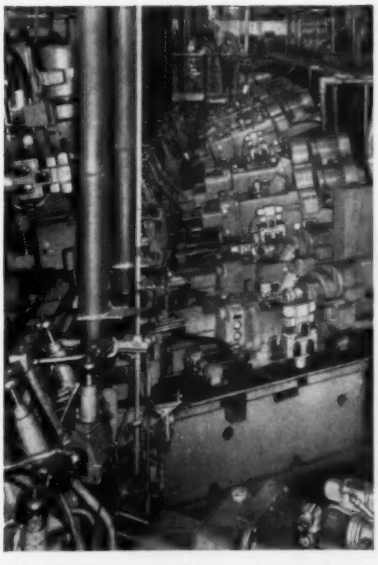
SNYDER TOOL & ENGINEERING CO.
SUNDSTRAND MACHINE TOOL CO.
WICKES MACHINE TOOL DIVISION
WILSON AUTOMATION COMPANY

VICKERS HYDRAULICS

HELPS CUT MAINTENANCE COSTS of Machinery Supplied by These Companies to This Modern Automated Plant



Typical transfer line installation shows ample use of Vickers hydraulics for actuation and control of automated operations.

High production is convincing proof of equipment reliability—one of many reasons why Vickers Hydraulics is engineered into equipment for modern automated production plants.

The above manufacturers find that Vickers Hydraulics simplifies installation and minimizes piping—benefits also enjoyed by the user. Vickers highly efficient pumps produce significant power savings . . . Vickers controls help minimize scrap and rework by providing precise positioning for machining and other in-process operations. Component dependability helps provide extended periods of uninterrupted production. Demountable unit construction simplifies on-the-job repairs and helps reduce downtime.

The Vickers complete line of components is ideally suited to hydraulic equipment standardization and interchangeability, reducing replacement inventory. Our application engineers will supply detailed information without obligation. General Catalog 5001B is available upon request.

7996

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

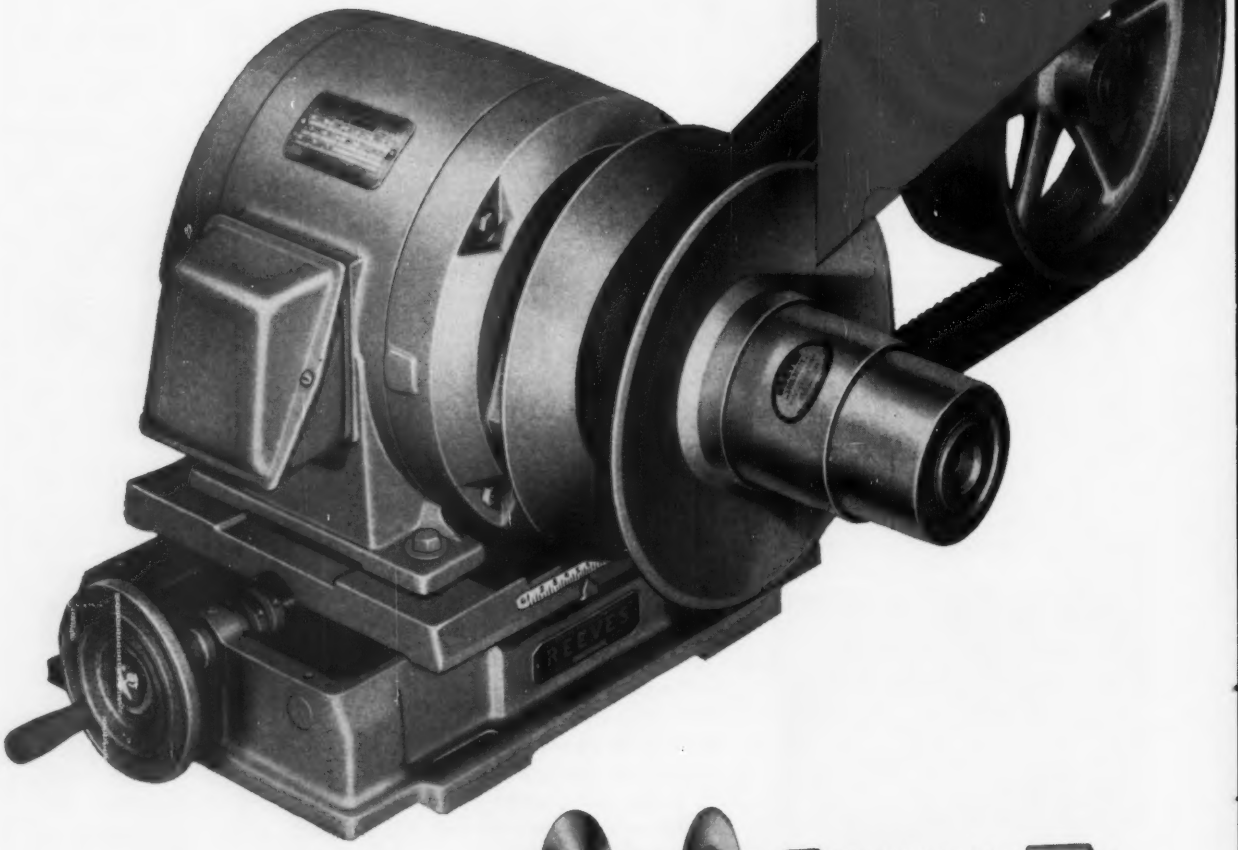
Application Engineering Offices: ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS TULSA • WORCESTER • Factories also in: AUSTRALIA, ENGLAND, JAPAN AND GERMANY • In Canada: Vickers-Sperry of Canada, Ltd., Toronto, Montreal and Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

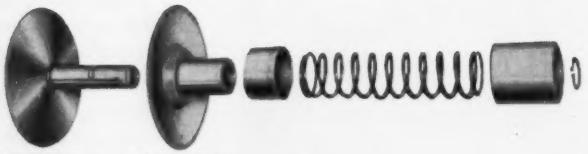
Circle 446 on Page 19

REEVES®

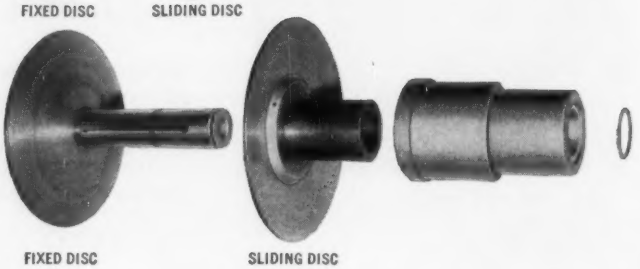
vari-speed MOTOR PULLEY



Sizes 95 and 96 Two-part spring cover, belt tension spring, and retaining ring.



Sizes 97 through 912-15
Pre-loaded safety cartridge for belt tension spring, and retaining ring.



● Here is variable speed control in its most simplified form . . . variable speed control with new economy . . . made possible because the new REEVES Vari-Speed Motor Pulley disc assemblies and bases are the simplest components available.

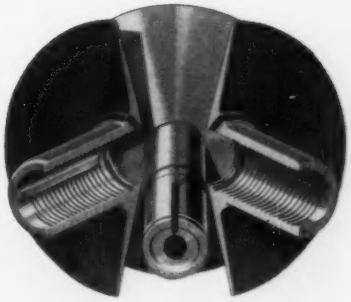
Disc assemblies have just three main parts: two smooth-face, cone-shaped discs —one mounted in fixed position on the motor shaft, the other designed to slide laterally on the hub of the fixed disc; and the belt tension spring. Belt tension spring automatically maintains pressure on the sliding disc for correct belt tension at all output speeds.

There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit old and new NEMA motors.

Separately mounted countershaft assemblies, in three sizes to match REEVES motor bases, are available to step-up or step-down output speeds.

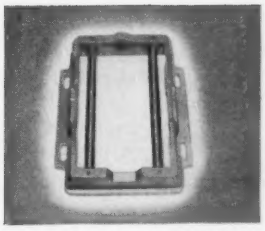
For complete information on Motor Pulley sizes and available controls, write for Bulletin H35-V582.

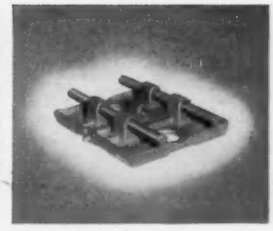
completely redesigned



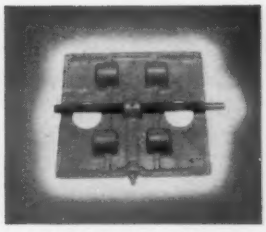
Split-section view of sliding disc shows how REEVES exclusive "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. No metal-to-metal contact . . . no "fretting" corrosion. One lubrication point services entire disc assembly, virtually eliminating sticking discs.

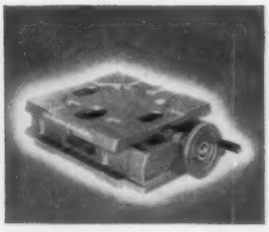
New precision bases—Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy, durable bases are manufactured on special automatic equipment to assure positive, easy adjustment and accurate speed control.





Base and motor slide rods manufactured for precision fit and true alignment.





Fully-lubricated shifting screw and precision features provide easy shifting.

REEVES PULLEY COMPANY

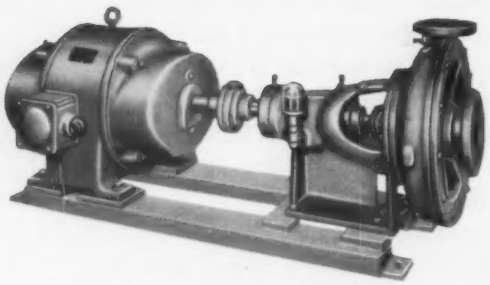
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 447 on Page 19

Production-built AMPCO® Pumps, FAFNIR-equipped, do job of costly "specials"

Interchangeable parts cut costs . . . provide unique pump versatility

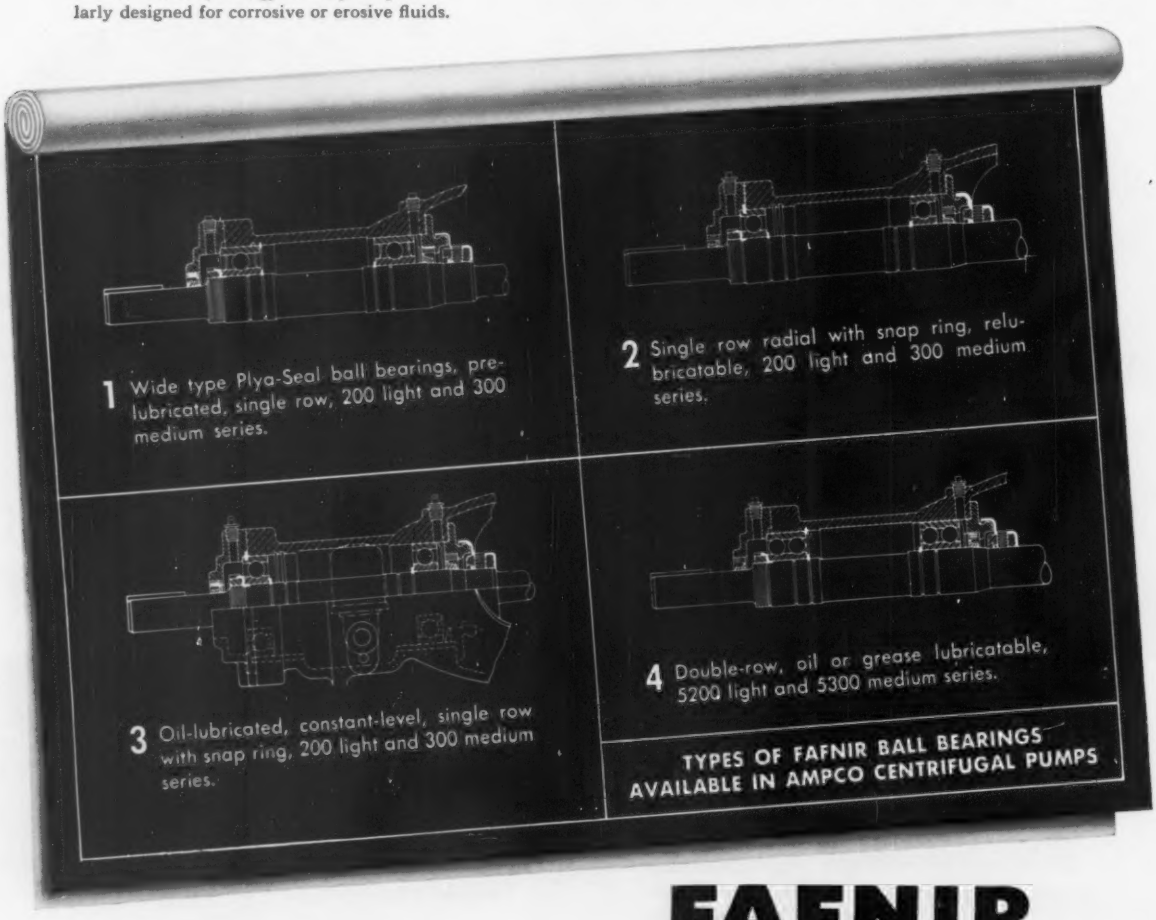


Versatile Ampco single-suction centrifugal pumps are available in sizes ranging from fractional flow to 600 gpm. They are particularly designed for corrosive or erosive fluids.

Centrifugal pumps manufactured with interchangeable parts by Ampco Metal, Inc., of Milwaukee are expressly designed to do jobs that would otherwise call for costly specials. They are also readily adaptable to new pumping requirements.

In designing this versatile pump series, Ampco needed various types of ball bearings. They found Fafnir had "all the answers" — bearings that met diverse size, load, speed, and lubrication requirements precisely.

Chances are, "the most complete line of ball bearings in America" holds the answers to *your* bearing problems. Write The Fafnir Bearing Company, New Britain, Conn.


1 Wide type Plya-Seal ball bearings, prelubricated, single row, 200 light and 300 medium series.
2 Single row radial with snap ring, relubricatable, 200 light and 300 medium series.
3 Oil-lubricated, constant-level, single row with snap ring, 200 light and 300 medium series.
4 Double-row, oil or grease lubricatable, 5200 light and 5300 medium series.
TYPES OF FAFNIR BALL BEARINGS AVAILABLE IN AMPCO CENTRIFUGAL PUMPS

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Circle 448 on Page 19

Circle 449 on Page 19→

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living . . . Through Chemistry

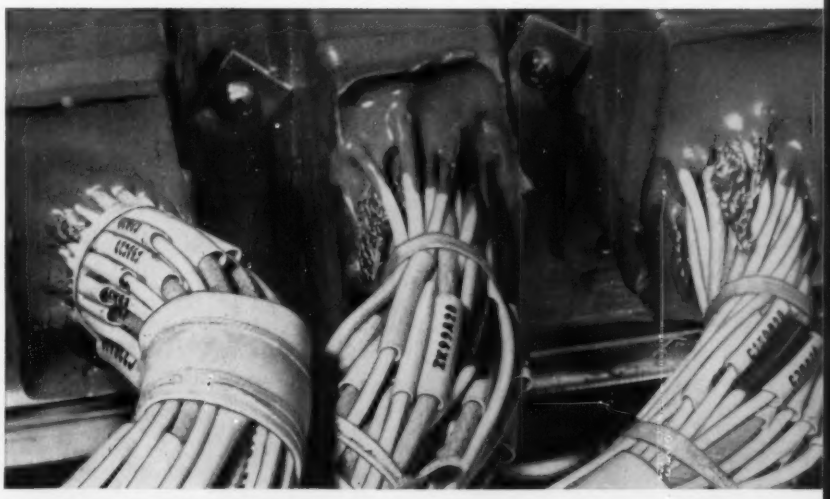
PRODUCT ENGINEERING NEWS
LATEST PROPERTY AND APPLICATION DATA ON
ZYTEL® nylon resins

Jacketing of Du Pont ZYTEL® nylon resin protects wiring against wear, heat, stress

Most of the wiring in the Martin MATADOR is covered with Du Pont ZYTEL nylon resin. ZYTEL is tough, providing excellent protection for primary insulation. The material has very high tensile strength and outstanding abrasion resistance. Wire made with ZYTEL is rated for use in the MATADOR from −67°F. to +221°F. Wiring protected by ZYTEL is employed in the guidance and control system of the missile, on the jet engine, and in the stabilizer controls.

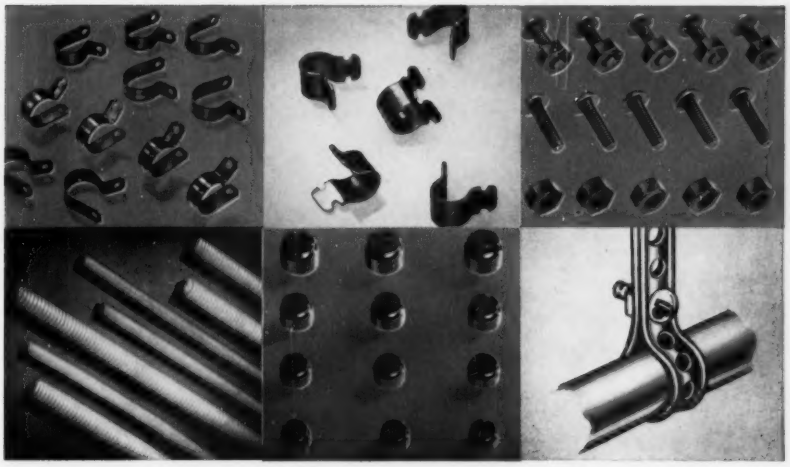
The coating of ZYTEL permits safe handling of wire during production and assembly. Cuts are prevented when grouping wires on harness boards or dressing them into the missile. Wires covered with ZYTEL withstand pulling through holes and are not damaged by clamping.

Problems due to difficult operating conditions can frequently be solved with the aid of Du Pont ZYTEL nylon resin. Learn more about wire protected with ZYTEL for use in your own designs. Request information by sending the coupon on the next page.



GROUPS OF WIRES protected by ZYTEL nylon resin terminate in components of the guidance system of the MATADOR guided missile. The wires withstand heat and cold, are insensitive to handling during production and assembly, can be pulled through openings without damage. (The USAF TM-61 MATADOR is manufactured by The Martin Company, Baltimore, Maryland.)

Rugged hardware made of ZYTEL® offers many design advantages



Shown here are cable clamps, clips, screws, threaded rods, nuts and perforated strapping—a few of the many hardware products being made of ZYTEL. These molded parts offer such advantages as light weight combined with great strength, good dielectric properties, excellent bearing characteristics. ZYTEL can be molded in colors to make designs more attractive . . . or for color coding. The material cannot rust and is unaffected by oils, grease or gasoline. (Parts illustrated are molded by the Weckesser Company, Chicago, Illinois.)

OVER

DU PONT

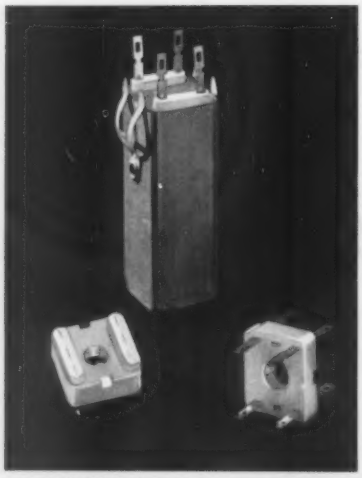
Better Things for Better Living ... through Chemistry

PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON ZYTEL® nylon resins

Strength, ease of assembly determine choice of ZYTEL® for electronic part

More than 200,000 of these I.F. transformer bases have been molded of ZYTEL over the past two years, with complete customer satisfaction. In addition to its excellent dielectric properties, ZYTEL is not brittle, does not chip or break at thin sections, and can be molded to uniformly close tolerances—in this case ± .003". The terminals are welded fast in their slots during assembly by the heat applied to them during soldering, providing a considerable advantage in production. ZYTEL withstands high cabinet temperatures, often encountered in electronic devices.



I. F. TRANSFORMER is mounted on a durable base of ZYTEL nylon resin, shown with and without inserted terminals. (Molded by W-L Molding Company, Kalamazoo, Michigan, for Sioux Radio Products, Yankton, South Dakota.)

Production cost of EDSEL carburetor part slashed 50% by use of ZYTEL® nylon resin

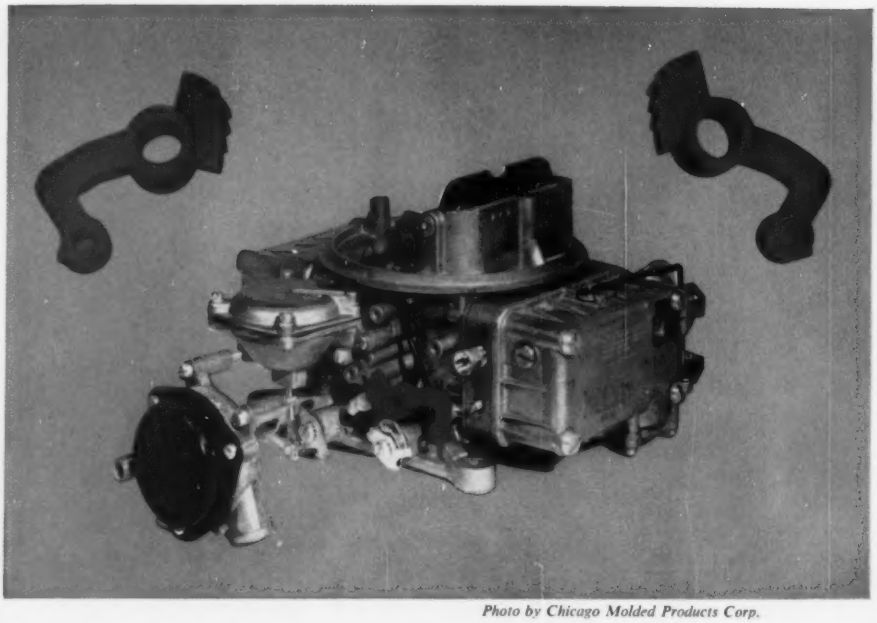


Photo by Chicago Molded Products Corp.

FAST IDLE CAM of the carburetor used on the new EDSEL automobile is made of ZYTEL nylon resin. The molded cam eliminates 3 finishing operations and saves over 50% in production costs as compared to metal. The cam automatically raises the idle setting when the engine is cold. (Part molded by Chicago Molded Products Corp., Chicago, Illinois, for Holley Carburetor Co., Van Dyke, Michigan.)

Use of ZYTEL nylon resin to make this carburetor cam speeds production, reduces costs, and results in a better part for the job. ZYTEL is ideal for this application because of its low frictional characteristics. Parts made of ZYTEL—such as gears, bearings, and cams—need little or no lubrication. ZYTEL is unaffected by engine compartment heat. Its high strength and exceptional resistance to abrasion provide long operating life.

The cam is injection molded by Chicago Molded Products Corp. in an eight-cavity mold. By using ZYTEL instead of metal, three finishing operations are eliminated and the cost of manufacturing the part is reduced by over 50%.

• • •

Similar advantages can be yours when you design with Du Pont ZYTEL nylon resins. Ask for the technical facts and examples of end-uses.

E. I. DU PONT DE NEMOURS & CO. (Inc.)
POLYCHEMICALS DEPARTMENT
Rm. 22-5-1, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada (1956) Limited,
P. O. Box 660, Montreal, Quebec.

Please send me more information on Du Pont ZYTEL nylon resins. I am interested in evaluating this material for:

NAME_____ POSITION_____

COMPANY_____ STREET_____

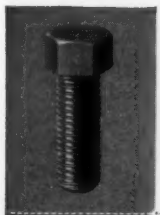
CITY_____ STATE_____ TYPE OF BUSINESS_____

SEND FOR INFORMATION

For additional property and application data on Du Pont ZYTEL nylon resins, mail this coupon.

FASTENING SPECIALTIES BY *National*

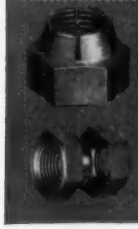
Get more dependable holding power for better product assembly with these National SPECIALTY FASTENERS!



Lok-Thred® Bolts, Studs, Screws—Seal and lock against involuntary loosening... Lok-Thred re-forms the metal of the receiving thread under high compressive stresses into intimate contact with itself, eliminating all voids. Yet, it's fully re-usable. Requires no selective fits. Can be used with ordinary tools. Available in all sizes of bolts, studs, screws... No. 6 or larger.

Spin-Lock® Fasteners—Give you strength at low cost, with self-locking, ratchet-tooth action... Spin-Lock machine and tapping screws have angled teeth to permit fast, easy tightening. They require about 20% greater torque to loosen. Available in pan, truss, flat and hex heads; slotted or Phillips recessed heads; No. 4 to ⅜" diameters, lengths from twice diameter and up.

Thread Cutting Screws—For joining metals or plastics without tapping... Use wherever it is desirable to remove rather than displace thread material. Four types: 1, 23, 25, and F cover most applications. Phillips or slotted heads, all styles, all sizes. Also type A and B tapping screws for fastening light sheet steel or light gauges of other metals.



Lock Nuts—Three types, to meet every requirement... 1. *Huglock*, for locking without seating and under adverse conditions. 2. *Marsden*, free-running until seated... for minimum-cost locking. 3. *Drake*, a two-piece design for use under severe stresses, shock, vibration. All types are all-metal, fully re-usable without loss of positive locking action.

Welding Fasteners and Weldnuts—Provide trouble-free assembly of fabricated metal parts... Use National welding fasteners when primary fasteners must be cleanly welded into exact position. National's complete line of projection welding screws and nuts is available in stock sizes, for optimum welds in materials .030 to ¼" thick. We will develop special designs for you.

Flex-Head® Locking Screws—Self-locking, highly resistant to fatigue, shock, impact... Tight locking results from flexing of the head and axial spring tension produced when fully torqued against a rigid seat. Flex-Head screws are identical in dimension, and interchangeable with standard machine screws. Made of 1022 steel and heat-treated for top strength.

Tuff-Tite® Cushioned Fasteners—Seal openings, eliminate vibration noises, absorb shock... Pre-assembled neoprene washers also prevent finish marring! Available as tapping screws, thread cutting screws, machine screws, roofing bolts, stove bolts, or wood screws; with Phillips or slotted heads; pan, round, truss or hex head styles.

Place® Bolts—Self-locking...resist impact, shock and fatigue failure by controlled spring action of reinforced, diaphragm head... Place bolts resist involuntary loosening when rigidly seated. Typical uses: connecting rod bolts, main bearing cap screws, flywheel bolts. Available in high carbon or alloy steel, in a wide range of sizes.

Save yourself time and trouble in searching for the right fastener. Make National your *one source* for standards, specialties and special designs. Our standard line includes all types and sizes... nuts, cap and set screws, machine bolts, carriage, step and elevator bolts, plow bolts; Phillips recessed head, or slotted, Sems, machine screws, wood screws; stove bolts, pipe plugs, cotter pins and rivets.

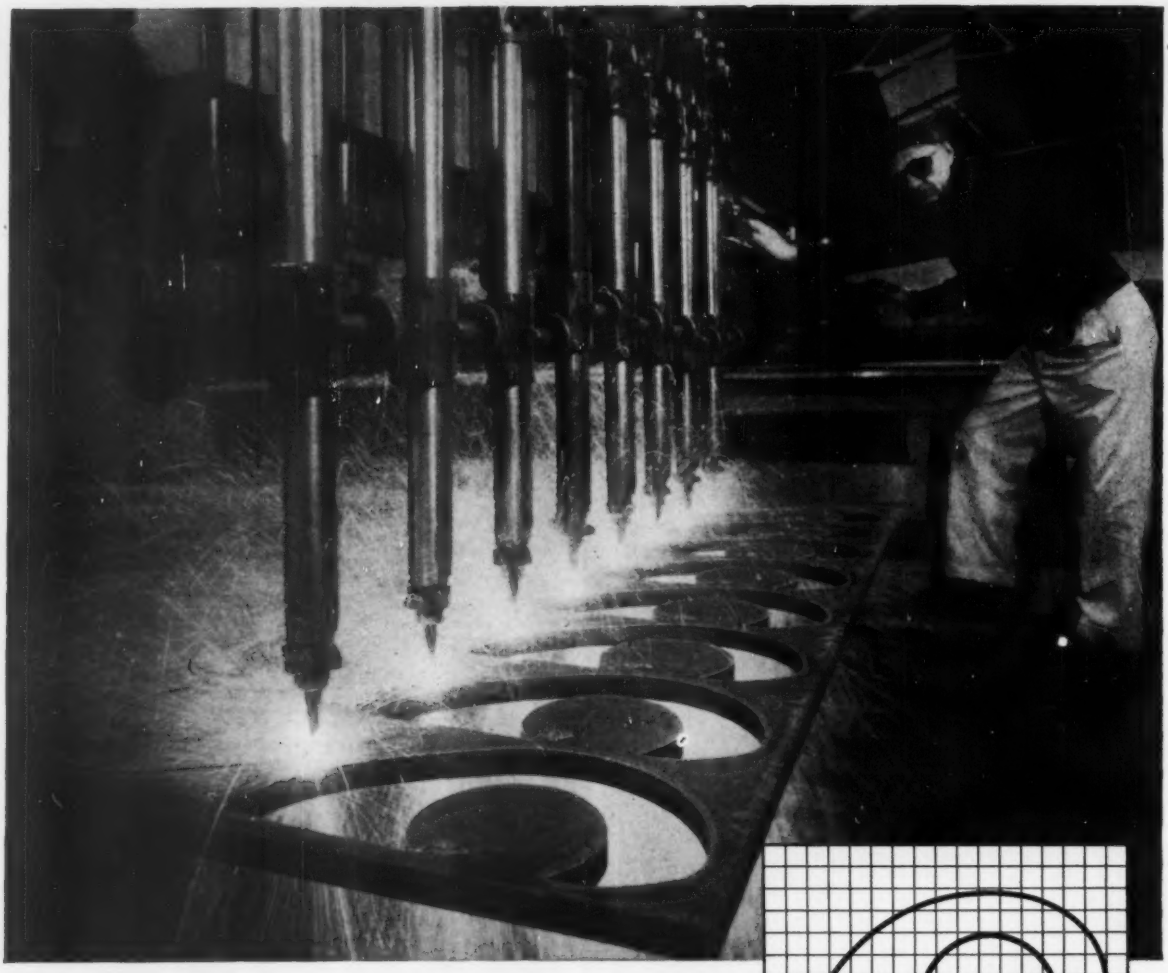
National can supply any nonstandard fastener, or design and produce specials for you. Write for National's *Special Products* booklet, or for information on the fastening specialty that interests you.

THE NATIONAL SCREW & MFG. CO. • CLEVELAND 4, OHIO

***Pacific Coast:* National Screw & Mfg. Co. of Cal. • 3423 South Garfield Ave., Los Angeles 22, Cal.**

National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**



One will get you 8

One outline drawing or templet is all you need to cut 8 pieces—simultaneously—with the Air Reduction No. 50 TRAVOGRAPH Gas Cutting Machine.

Equally important, since it runs on rails, the No. 50 TRAVOGRAPH can cut individual shapes of unlimited length up to 12 feet wide. And cuts are accurate, so that little or no finishing is needed.

The No. 50 TRAVOGRAPH motorized torch holder adapters provide compound angle settings. The Multi-Bevel Unit prepares plate edges with precise single or double bevels, with or without lands. Tracers are electronic, manual, magnetic or spindle. High speed or standard cutting tips for the No. 50 TRAVOGRAPH are available for any fuel gas you prefer.

Write for technical data, or call the Air Reduction Sales Office nearest you.

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AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT • Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** – carbon dioxide – gaseous, liquid, solid ("DRY-ICE") • **OHIO** – medical gases and hospital equipment • **NATIONAL CARBIDE** – pipeline acetylene and calcium carbide • **COLTON** – polyvinyl acetate, alcohols, and other synthetic resins.

NEW FROM Saginaw

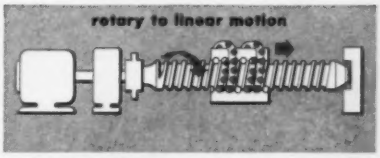
PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: only 3/16 inch

SMALLEST ball/bearing SCREW OFFERS BIGGEST ANSWER TO CRITICAL POSITIONING/CONTROL PROBLEMS

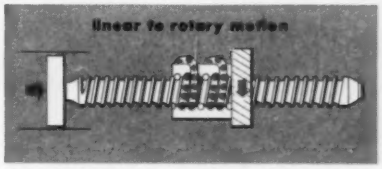
Another timely development by Saginaw . . . for imaginative manufacturers of ultra-precise controls in the electrical and electronic fields. For Saginaw Miniature b/b Screws will solve critical positioning/control problems for radar tuners, missile and rocket guidance and telemetering systems, automatic switch-gears, electronic machinery controls . . . plus a host of other applications.

These amazing little fellows are so compact and weigh so little—you can save greatly on space and weight. So efficient—over 90%—you can use much smaller motors and gear boxes. So precise—you can position components within .0005 inch per inch of travel. (If application requires, lash can be eliminated.) So dependable—you can rely on remarkably long service life even in extremely adverse environments.

Every day Saginaw's experienced engineers are helping more and more forward-looking manufacturers to gain these advantages of Saginaw Miniature b/b Screws. Let them help you plan your application. No obligation. Simply phone, write or mail the convenient coupon below.



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

Saginaw
ball bearing Screw

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN
WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

SEND TODAY FOR FREE 36-PAGE ENGINEERING DATA BOOK . . .
or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 11MD, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Circle 452 on Page 19

Tiny Tankers. Unicellular diatoms floated on prehistoric seas in infinite numbers, each encased a microscopic fat globule. Today, coalesced, they comprise the oil pools we draw upon. A wonder-of-the-world in miniature, truly a miracle of nature.

Magnetic Oil Finder. Modern triumph of miniaturization is the sensitive aerial magnetometer which trails an airplane for magnetic field surveys, locating new oil resources. 29 MPB bearings in it reduce friction for measuring accuracy 1 to 2 parts per 50 thousand.

Man With Miracles. This is Harry Hannan, MPB's Senior Applications Engineer. He can help you find exactly the right type of bearing for your application and reduce friction to a minimum, provide instrument sensitivity and maintain reliable, trouble-free operation.

Miracles in Miniaturization All around you

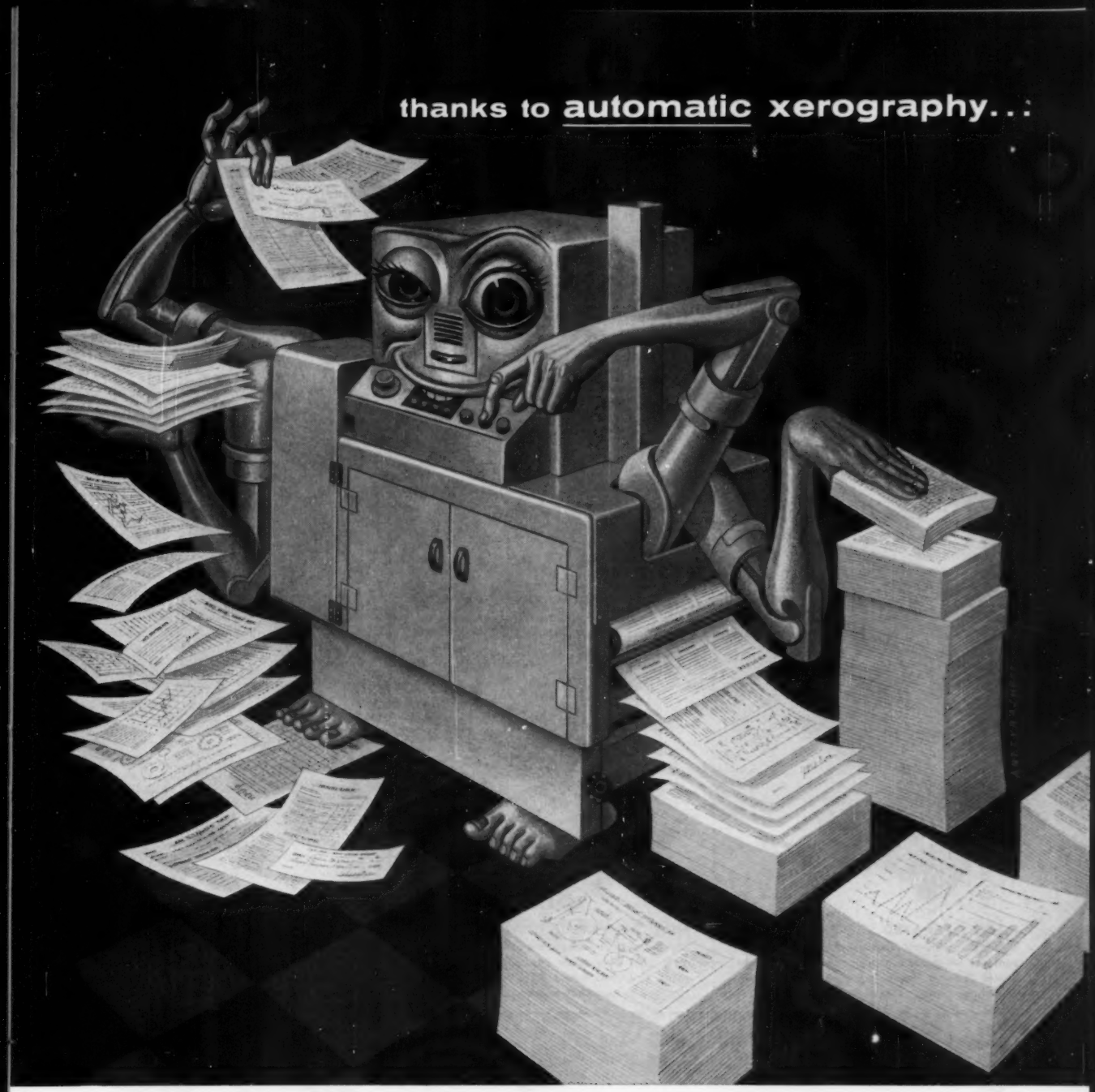
BEARING ACTUAL SIZE

New Industrial Miracles are still to be created by inquiring scientific minds. Projects move along more quickly because MPB bearings are solving so many problems of friction, precision and mechanics. MPB is a pioneer in miniaturization . . . puts its wealth of experience at your disposal. More than 500 types and sizes of miniature bearings available . . . specials on request . . . engineering and research facilities second to none. For engineering assistance and/or new catalog, write **Miniature Precision Bearings, Inc.,** 105 Precision Park, Keene, N. H.

MPB

Helps you perform miracles in miniaturization

Circle 453 on Page 19



Push the button and copies flow!

Here, as caricatured by Artzybasheff, is the mighty Copyflo® continuous printer—*automatic,* push-button xerography at its brilliant best—whose enormous appetite for volume copy problems is matched only by its speed, versatility, and high quality of output.

Wherever low-cost, volume copying is the need, look to automatic xerography for the happy solution. Copyflo printers turn out *dry,* positive prints up to 11 or 24 inches wide (depending on model), ready for immediate use. Copies emerge at the rate of 20 feet a minute, an 8½" x 11" print in less than three seconds.

Copyflo continuous printers enlarge, reduce, or copy size to size. They offer the speediest, most flexible, most economical way to get copies precisely like the original from microfilm or original documents.

For further information write to: Dept. 58-185X, Haloid XeroX Inc., Rochester 3, N. Y. Branch offices in principal U. S. and Canadian cities.

HALOID XEROX®

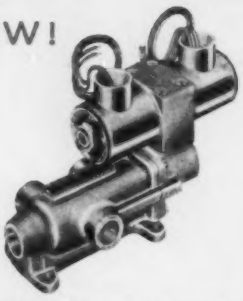
Circle 454 on Page 19

SCHRADER ADDS MORE NEW AIR CONTROL PRODUCTS TO GIVE YOU EVEN WIDER SELECTION

NEW!

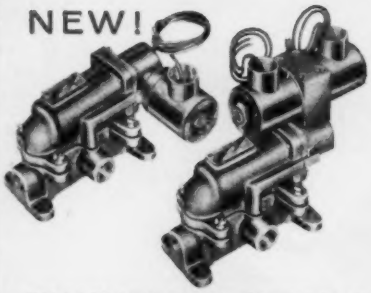
HOSE REEL FOR AIR TOOL SUSPENSION —Saves duplicate equipment and maintenance. Saves time on high speed production. Spring tension counterbalances air tools. Powerful spring automatically takes up tool.

NEW!



DOUBLE SOLENOID 4-WAY VALVES — Now double solenoid 4-way action available in full series . . . voltage-wise, port size, flow capacity. Permits longer dwell time in either position without continuous electrical energy.

NEW!

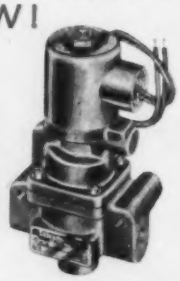


SUB-BASE SINGLE AND DOUBLE SOLENOID VALVES — Greater versatility. You don't have to disturb the piping for service. Reduces "down time" to absolute minimum. Complete series: voltages, sizes, capacities.

NEW!

PILOT OPERATED SUB-BASE 4-WAY VALVES — Sturdy cast meehanite sub-base contains all ports for piping air. Permits removal of valve mechanism for service without disturbing piping. Complete new series!

NEW!

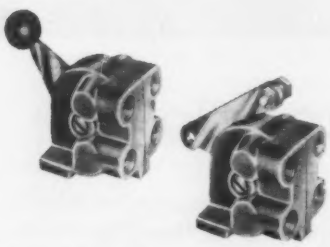


NEW! 3-WAY SOLENOID VALVES—Simple 3-way action available in full series—voltage, port sizes, flow capacities. By shifting pilot chamber head 90°, normally open changes to normally closed, and vice versa!

NEW!

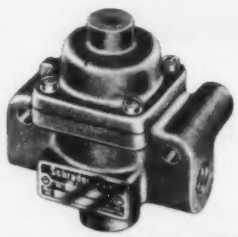
2- AND 3-WAY FOOT VALVES — With right angle ports. Give convenience and control with simplest installation. Mount directly on floor. ⅜" N.P.T. Sturdy, compact, and *versatile*. Take minimum space.

NEW!



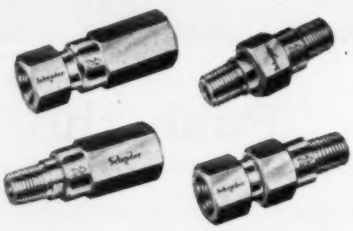
SLIDING SEAL VALVES FOR PIPED EXHAUST — Complete series! 2, 3, 4-way types. ¼" N.P.T. ports. Hand or mechanical lever. Compact, minimum working parts.

NEW!



3-WAY PILOT VALVES — Complete new line. Normally open or normally closed types. Ideal for single-acting cylinders. Simple, neat, sturdy. May easily be converted to solenoid.

NEW!



CHECK VALVES—Thread combinations now in complete series in spring-loaded check type. Pinpoint your needs. Amazingly compact, relative to large flow capacity. Capacity 35 cu. ft.

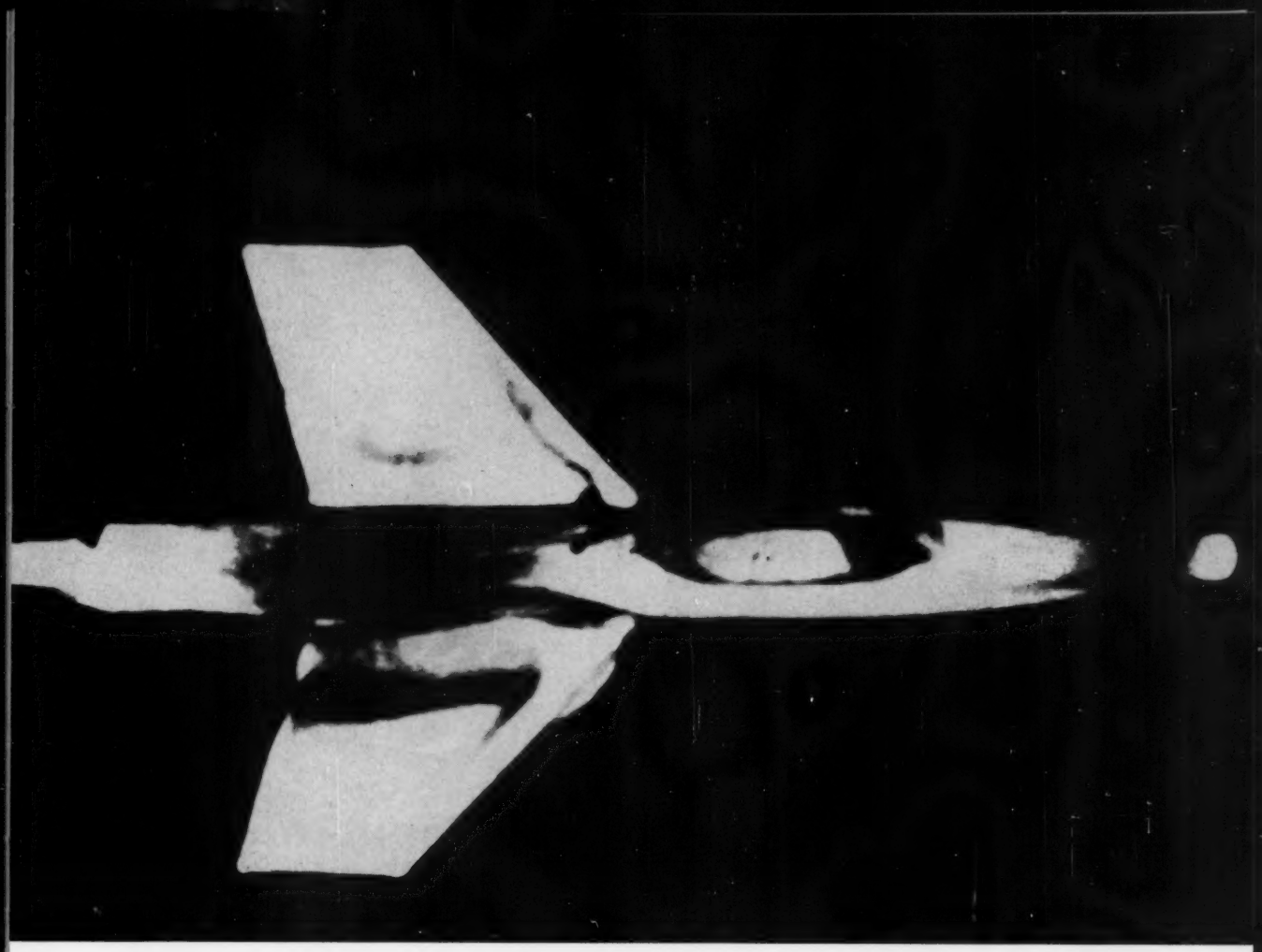
Schrader®
a division of SCOVILL

Use the full Schrader line to do your air control selecting. Your Schrader distributor can help you pinpoint what you need. For more data write:

A. SCHRADER'S SON • *Division of Scovill Manufacturing Company, Incorporated*
476 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR PRODUCTS

Circle 455 on Page 19



thermal thicket

The thermal barrier which now limits the speed of ultra high speed aircraft can be cracked. Needed: Structural components of elevated temperature alloys. Problems: Finding the right alloys; making them easy to forge and machine with regular production-line tools; maintaining uniformity of physical properties in production lots.

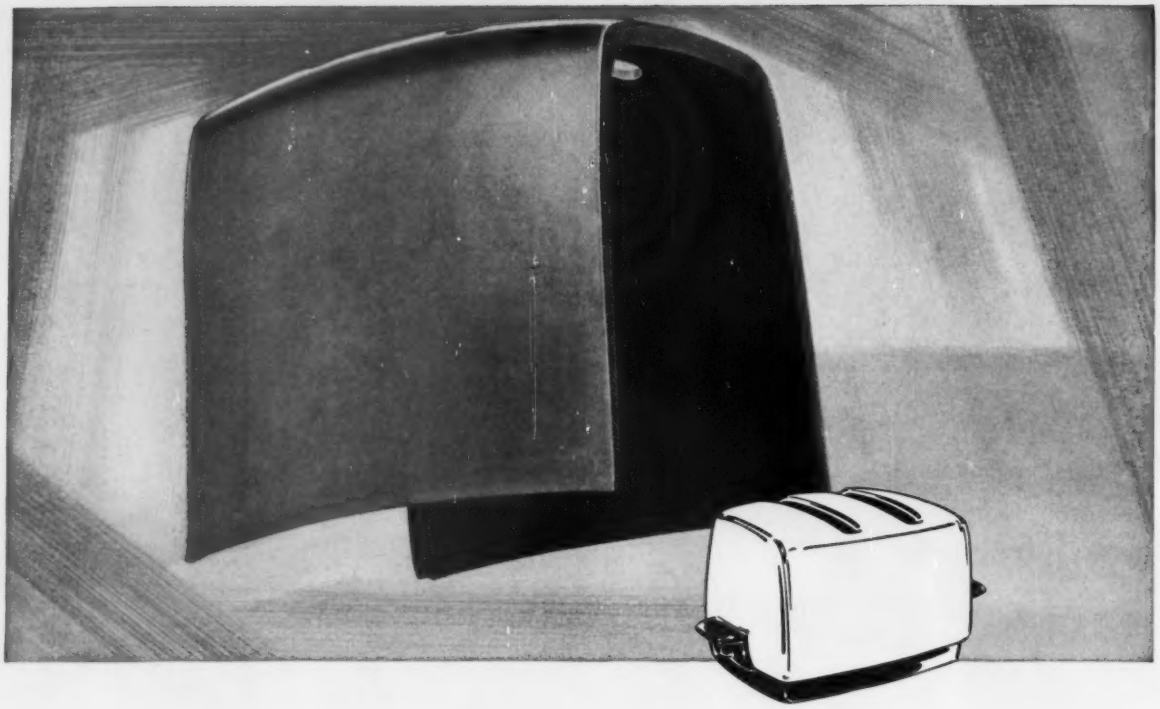
Right now, Carpenter is producing elevated temperature alloys which set new standards for consistent ability to meet tough aircraft specifications, high quality, improved forgeability and machinability. Engine builders find them ideal for many critical parts. Forge shops can work them to closer tolerances, get better finishes that require far less than usual machining. Work goes faster. Rejects are fewer.

You can get the full story of these alloys — their application, fabrication and engineering properties — in the new booklet, "Carpenter Alloys for Elevated Temperature Service". Get your personal copy by writing on your Company letterhead. The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

Circle 456 on Page 19



Form flat-polished metal without marring!
Use Bonderite and Bonderlube

Multiple head flat polishing at Production Finishing Corporation, Detroit.

Polished sheets are treated with Bonderite and Bonderlube before forming.

Bonderite and Bonderlube protect that smooth, flat-polished finish through forming and fabricating. Parts go direct to the plating bath from forming operations with only a light buffing.

All types of products are being made this way—automobile bumpers, automotive trim, toaster and small appliance bodies, home laundry equipment components and many other formed parts.

Cost reductions are big with Bonderite and Bonderlube: Polishing costs on bumpers went from 9c a square foot for contour polishing to 0.8c a square foot for flat polishing before forming. Savings of 10c to 30c a square foot have been reported by other industries.

The Parker technical representative has full information on this cost-cutting combination. A letter or phone call will bring it to you.

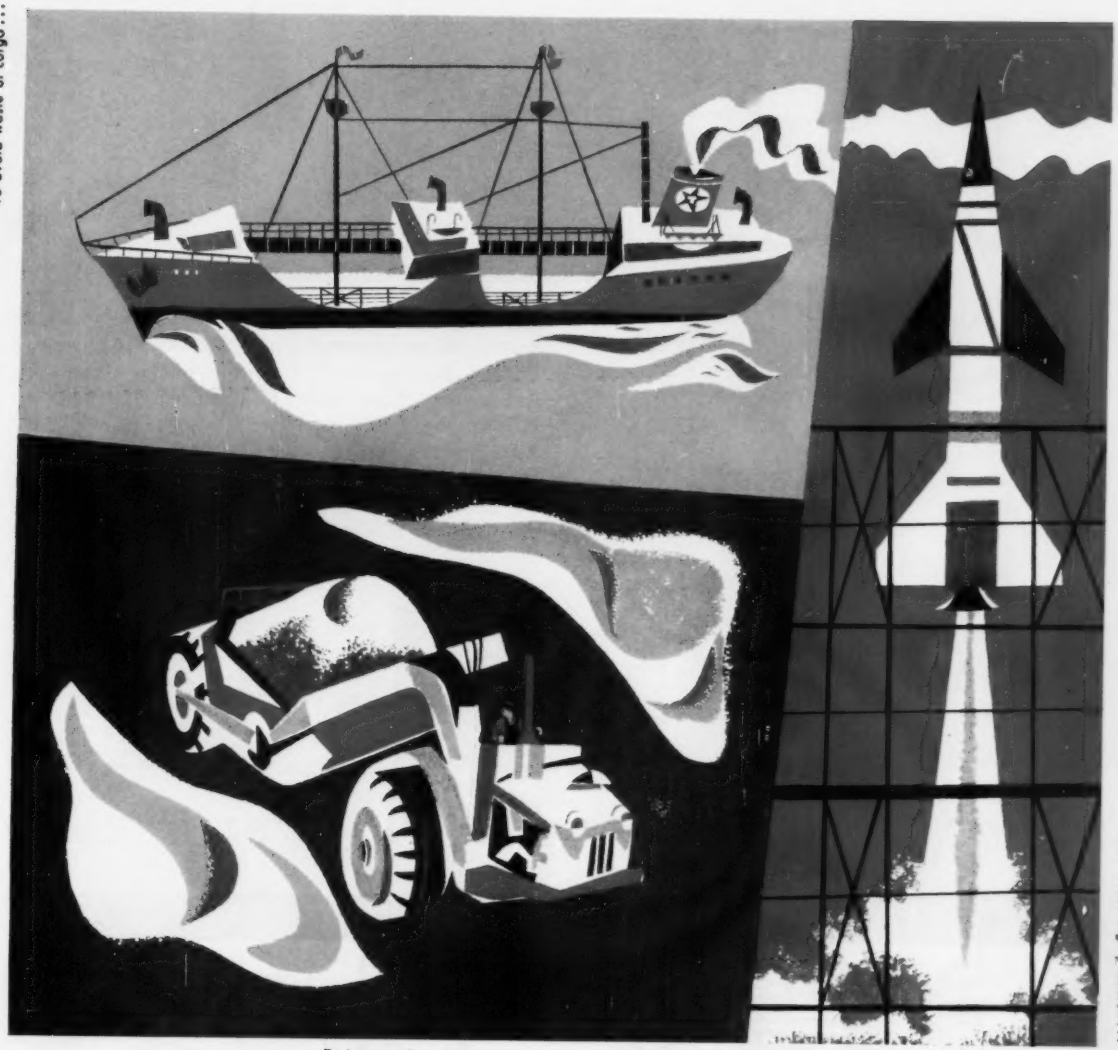
Since 1914 — leader in the field

PARKER RUST PROOF COMPANY
2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

*Bonderite, Bonderlube, Parco, Parco Lubrite, Reg. U.S. Pat. Off.

Circle 457 on Page 19



SWITCHES SET OFF BY SPEED!

AC engineers have designed a speed sensing control that is accurate to ½ of 1% at engine speeds ranging from 500 to 4600 rpm. This AC Speed Switch triggers up to four turbine engine functions. It takes the human element of error out of any operation where precise speed sensing is a critical factor.

Yet, the AC Speed Sensing Control weighs only about four pounds. It is compact, can be mounted anywhere and can take the roughest kind of treatment. It will withstand high engine vibration without losing calibration . . . functions for long intervals without overhaul.

Call AC-Milwaukee for additional details.

—Or, if you are an electrical or mechanical engineer, and would like to work in Milwaukee, write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept. C, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

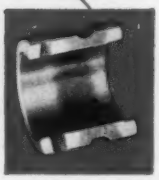
Producers of: AChiever Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Speed Sensitive Switches • Speed Sensors • Torquemeters

SEALMASTER'S EXCLUSIVE COMBINATION OF FEATURES ARE SETTING THE PACE!

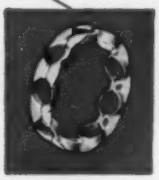
When you design, you design your products for maximum performance—and **Sealmaster** helps you attain it. **Sealmaster** Ball Bearing Units are engineered and manufactured with the same painstaking quality control you would insist on maintaining within your own plant. **Sealmaster's** exclusive combination of features assure you of maximum performance for each bearing. You'll want full information on how important these features are to you and your own product's performance.

LOCKING PIN & PERIMETER DIMPLE—prevents rotation of outer race and assures positive lubrication.

LABYRINTH-SEAL—keeps dust and dirt out and lubricant sealed in for long bearing life.



ZONE HARDENING—assures positive race to shaft holding power.

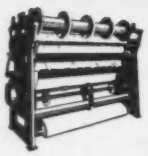


LANDRIDDEN BALL RETAINER—eliminates ball wear, traps grease and prevents churning.

...For Outstanding Bearing Performance

MACHINE TOOLS

SEALMASTER quality pays off where the trend is to continuous, fast, automatic equipment.



TEXTILE INDUSTRY

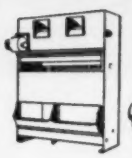
Clean, fast production is assured with SEALMASTER Bearings.

FARM MACHINERY

SEALMASTER Ball Bearing Units keep dust and dirt out, lubricant in—a feature Farm Machinery demands.

CONVEYORS

SEALMASTER Ball Bearing Units are featured by manufacturers of many types of conveyors.



AIR CONDITIONING

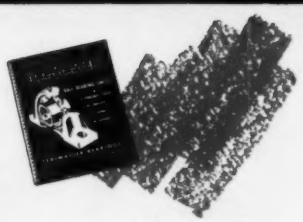
Quiet, trouble-free performance is assured with SEALMASTER. Find out about new rubber mounted units.

CONSTRUCTION MACHINERY

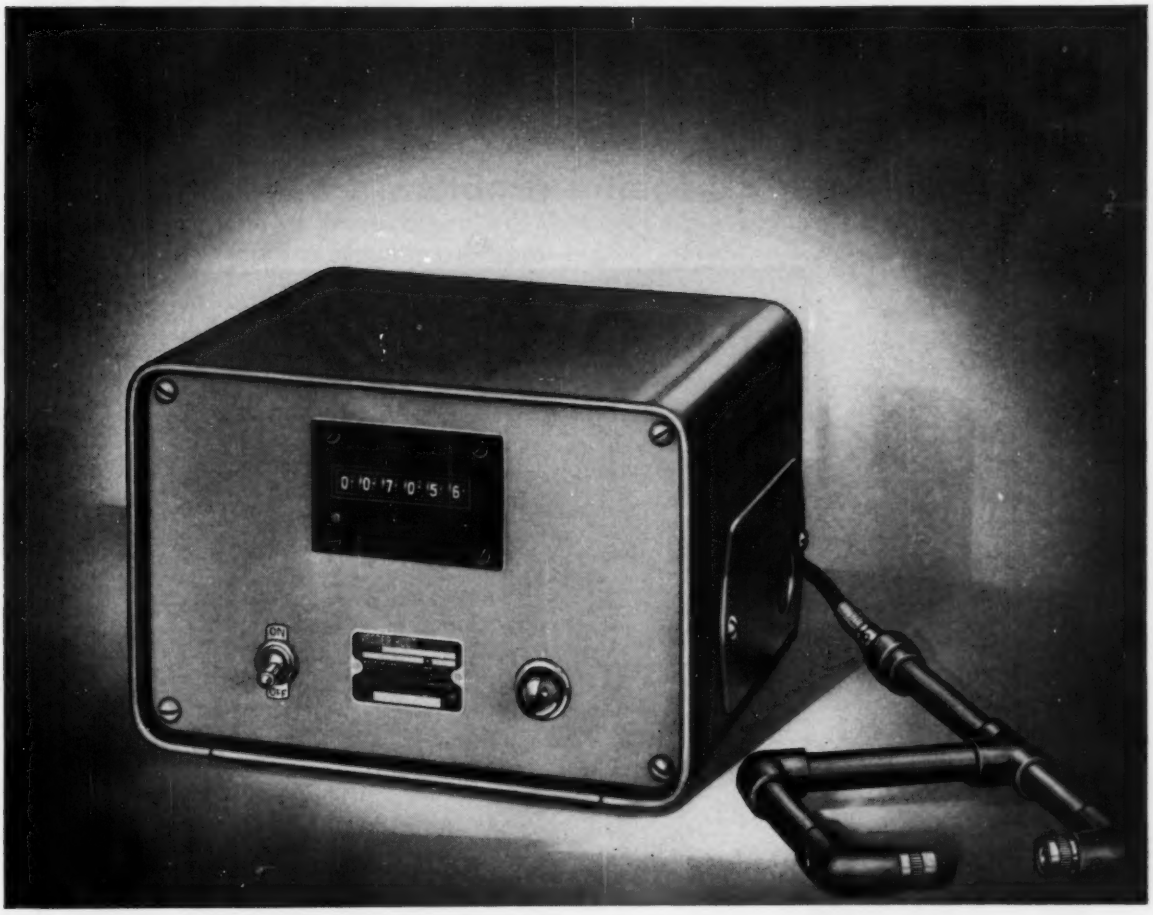
SEALMASTER Ball Bearing Units provide the features for gruelling performance in construction and materials handling equipment.

SEALMASTER® BALL BEARING UNITS

Write for Bulletin 454



SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. 18 RIDGEWAY AVENUE, AURORA, ILL



New VEEDER-ROOT Electronic "Count-Pak"*

A COMPLETE COUNTING PACKAGE!

High Speed . . . Electric Eye
. . . "Pulse Stretcher"
. . . Instant Reset

First of a new series of electric and electronic counting "packages" is this Model C "Count-Pak" . . . consisting of the new V-R instant-reset, high-speed (3,000 counts per minute) electric counter combined with a light source and photo cell.

Cell and light source can be adapted to any application . . . and are permanently assembled so vibration can't jar them out of focus. Pulses as short as .0002 seconds will actuate this device, which means that a ¼" object or space moving at 6,000 feet per minute will be counted. "Count-Pak" is transistorized throughout (no tubes) and utilizes printed circuits . . . double assurance of instant action and long trouble-free life. Rugged, compact case: 8¼" wide; 5¼" high; 6¼" deep. Panel includes pilot light, reset button, and power switch. *And prices are unexpectedly low.* Write:

*Trade-mark registration applied for.

EVERYONE CAN COUNT ON

Veeder-Root
INCORPORATED
HARTFORD 2, CONNECTICUT

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
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New Team . . .

TITANIUM AND ZIRCONIUM

for your corrosion problem areas

TYPICAL CORROSION RESISTANCES OF ZIRCONIUM AND TITANIUM

CORROSIVE MEDIA	METAL RESISTANCE	
	ZIRCONIUM	TITANIUM
Sulfuric Acid	excellent to good below 80%	good below 5%
Nitric Acid	excellent	excellent
Hydrochloric Acid	excellent	good below 10%
Phosphoric Acid	excellent to fair below 85%	poor
Chromic Acid	excellent	excellent to good
Aqua Regia	poor	excellent
Wet Chlorine Gas	poor	excellent
Chlorine Water	excellent	excellent
Sodium Hydroxide	good below 90%	good below 50%
Ferric Chloride	poor	excellent
Calcium Chloride	excellent	excellent
Cupric Chloride	poor	excellent
Sodium Chloride	excellent	excellent
Ammonium Chloride	excellent	excellent
Aluminum Chloride	excellent	excellent to fair

Chart shows corrosion resistances of zirconium and titanium to typical chemicals.

Steam jet made of zirconium, which has given trouble-free performance after a year in hydrochloric acid service. For comparison, a throat piece from a steam jet (below) is shown after only a week of similar service.

By specifying titanium or zirconium for processing equipment, you can now overcome most of the corrosive media which attack other metals.

Even with such hard-to-handle chemicals as chlorides and oxidizing acids, equipment can have extremely long service life when made from these corrosion-resistant materials. Problems of product contamination in chemical and food processing can also be virtually eliminated.

Mallory-Sharon is in position to offer you *both* titanium and zirconium mill products for equipment fabrication—plus engineering assistance and unbiased recommendations on the most suitable material.

Titanium is now available from stock in a complete range of mill products, may be readily fabricated, and more than pays its extra cost where ordinary metals fail. Zirconium facilities are being rapidly increased, and mill shapes are now in production.

For information on the corrosion-resistant properties of titanium or zirconium write Mallory-Sharon Metals Corporation, Niles, Ohio.

MALLORY-SHARON

METALS CORPORATION • NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

Circle 460 on Page 19

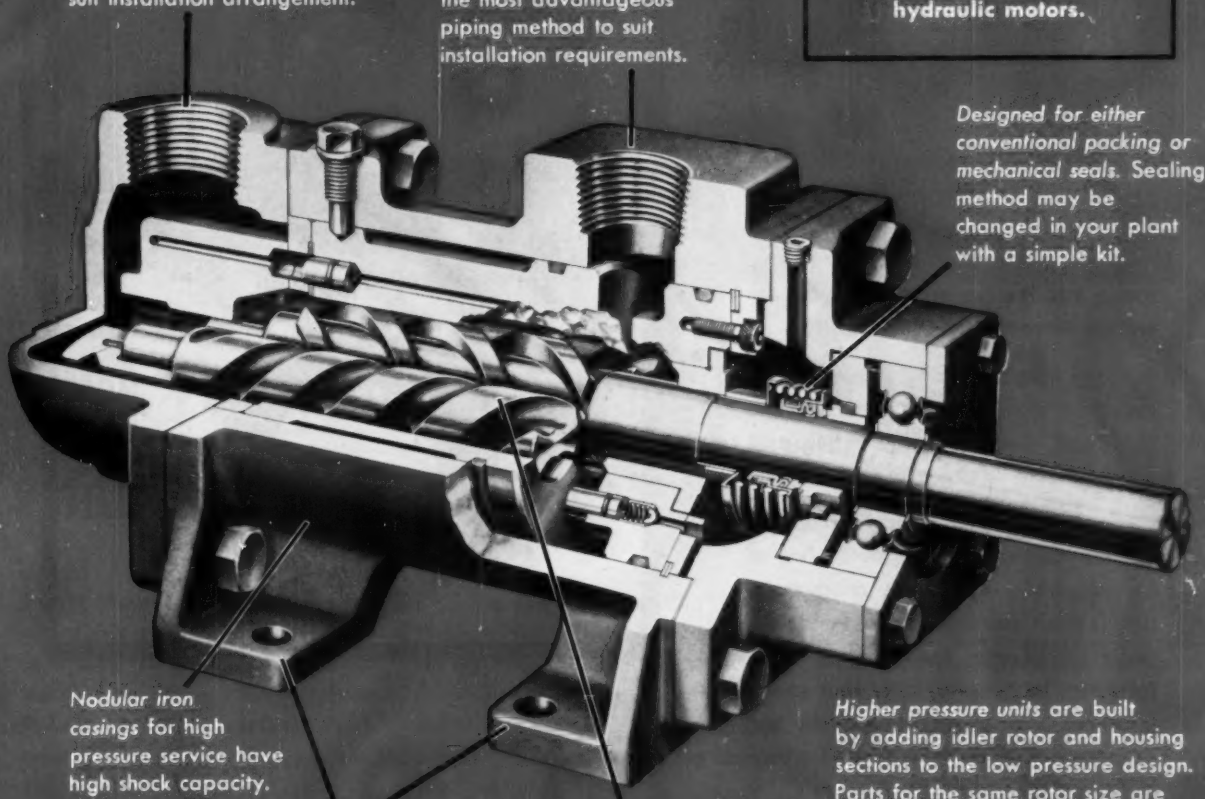
DE LAVAL
IMO PUMPS

are now more versatile than ever

De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.



Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Any position mounting is possible without factory modification.

Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

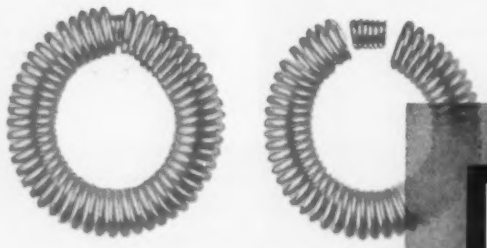
DE LAVAL STEAM TURBINE COMPANY

Nottingham Way, Trenton 2, New Jersey

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

DL 415

How a change in spring design can reduce cost and improve performance.



FIRST DESIGN

IMPROVED DESIGN

In the original conception of this switch retaining spring, an extension spring was formed into a garter spring by inserting a small plug in the form of a spring into the two ends. Assembly operation proved difficult and costly.

In the redesigned spring, one end is reduced in diameter and inserted into other end, eliminating the spring plug and providing stronger unit.

Early consultation with our spring specialists, following the determination of fundamental performance characteristics, is often insurance against unnecessarily complicated manufacture. Write for pamphlet "How to solve your spring problems." Gives case histories and valuable design considerations for various types of springs.

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
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Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

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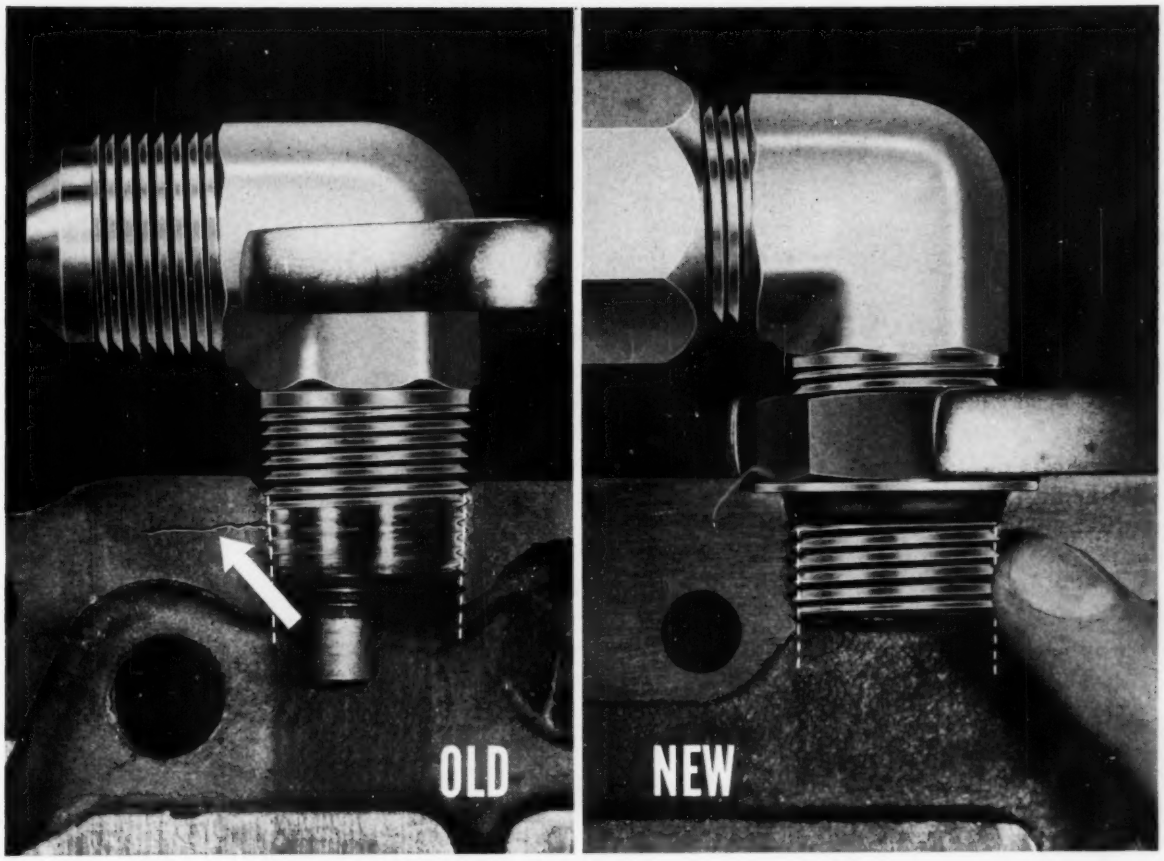


How Parker straight-thread fittings solve leakage problems

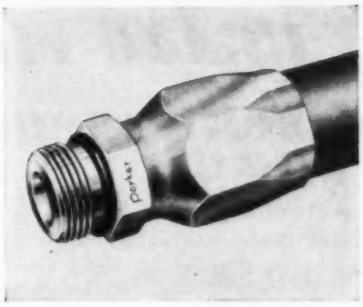
Forget about danger of cracking or distorting valve bodies by overtightening the fittings. Forget about messy pipe "dope." Forget about leakage problems resulting from tapered pipe threads in high-pressure hydraulic systems.

Eliminate these problems. Use Parker O-ring seal straight-thread fittings (which conform with the SAE Standard for Hydraulic Tube Fittings) for leakproof, trouble-free connections. Available on Parker *Triple-lok* (the industrial standard flare tube fitting) and on Parker *Ferulok* (flareless fitting for heavy steel tubing).

Ask your Parker Distributor today, or mail the coupon for complete information about Parker straight-thread fittings.

PARKER FITTINGS AND HOSE DIVISION

Parker Hannifin
creative leader in fluid systems



New, Broader Line of *Hoze-lok* fittings for medium- and high-pressure hydraulic service. Longer performance, greater re-usability. No skiving of hose. Easier make-up saves time and money.

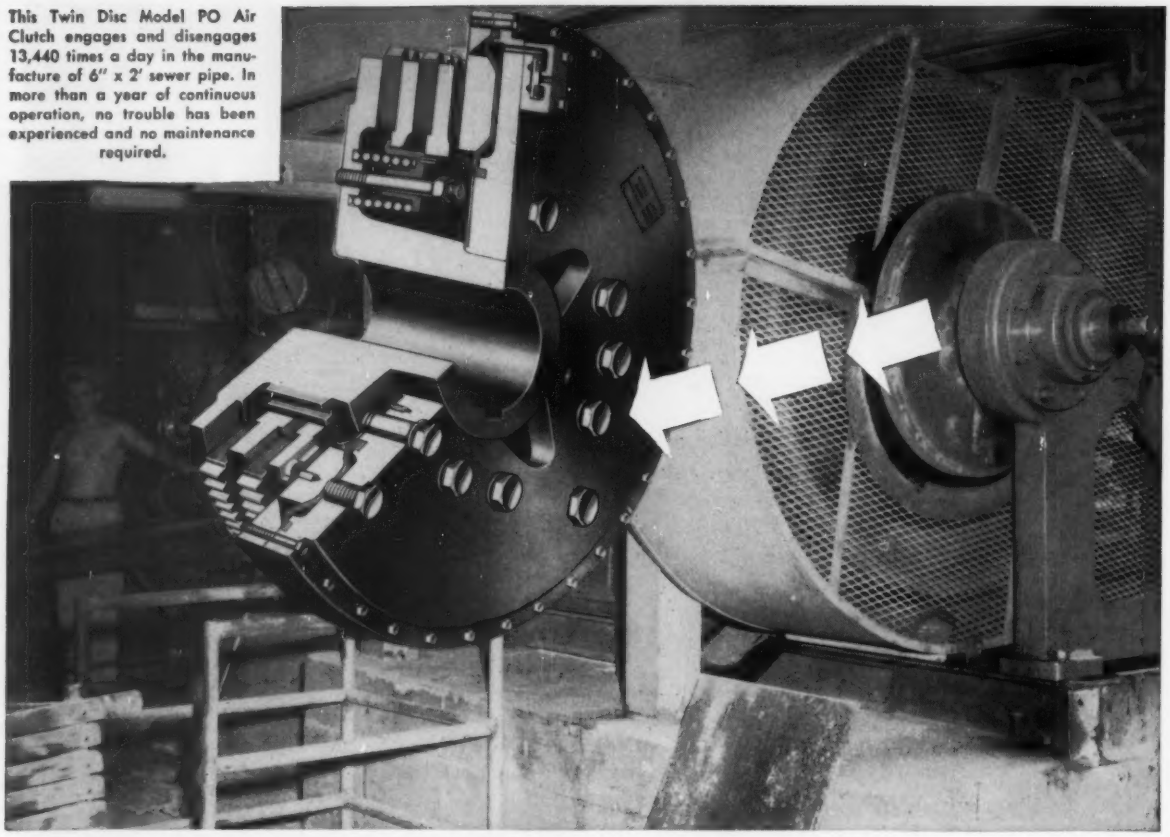
PARKER FITTINGS AND HOSE DIVISION
Section 436-V
Parker-Hannifin Corporation
17325 Euclid Ave., Cleveland 12, Ohio

Please send:
- ☐ *Triple-lok* Fitting Catalog 4310
- ☐ *Ferulok* Fitting Catalog 4320
- ☐ *No-Skive Hoze-lok* Catalogs 4433 & 4434

Name_____ Title_____
Company_____
Address_____
City_____ State_____

Circle 462 on Page 19

This Twin Disc Model PO Air Clutch engages and disengages 13,440 times a day in the manufacture of 6" x 2' sewer pipe. In more than a year of continuous operation, no trouble has been experienced and no maintenance required.



13,440 clutch engagements and disengagements a day...every day

A Twin Disc Model PO-224 Air Clutch *proves itself 13,440 times a day—every day*—at the Natco Corporation, leading manufacturer of clay sewer pipe, when 6" x 2' pipe is produced at their Brazil, Indiana plant.

This clutch is an *integral part* of a J. C. Steele Automatic Horizontal Extrusion Machine used to produce pipe in 4", 5", 6" and 8" sizes. For each pipe produced, the clutch engages and disengages to form the bell of the pipe and to subsequently extrude the proper length.

After more than a year of continuous operation, no trouble whatsoever has been experienced and no maintenance has been required.

Developed specifically for heavy-duty installation such as this, the Twin Disc Model PO Air Clutch's advanced design features offer many advantages, including *less shock loading* during starting cycles . . . *higher torque capacity* (up to 126,600 lbs. ft.) . . . *more compact installation* . . . *faster, smoother operation* under all working conditions; no seal drag . . . *positive, quick release*—provided by exclusive Twin Disc diaphragm design . . . *long, trouble-free operating life,* with extra-large air passages from cored backplate providing "air-flow" cooling to the diaphragm insulator plate, the springs and the driving plates.

If *you're* planning or designing new equipment that requires a lighter, more compact remote control of power transmission without complicated linkage . . . write *today,* for complete details on the Twin Disc Model PO Air Clutch. Request Bulletin 304.

TWIN DISC

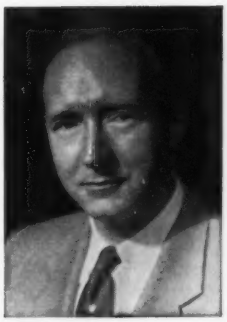
TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division) Rockford, Illinois

Circle 463 on Page 19

MACHINE DESIGN
May 1, 1958



For a Stronger Profession

IN MOST engineering organizations today the situation is as it would be in a hospital if a meager staff of doctors also had to do all the nursing." That is how the operation of our profession looks to a qualified observer, Dr. Edward U. Condon.

An engineer also may be likened to a highly alloyed heat-treated material capable of sustained performance under rigorous service conditions. We don't use such materials for simple applications at low stress. Ordinary materials do an adequate job at less expense.

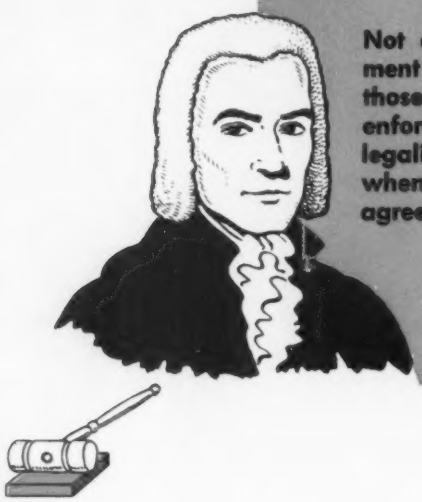
Yet when we put engineers to routine tasks that could just as well be done by clerks or technicians, we are in effect using a high alloy to do a low-alloy job—or a doctor to do nursing.

For years industry cried "shortage," at the same time that it was employing engineers at only a fraction of their potential. But now many companies cannot afford to hire all the engineers they need to operate under present inefficient utilization practices. It therefore becomes doubly important to develop maximum effectiveness of those they have, through judicious use of supporting personnel. The current installment of "Organizing for Productivity," Page 28, points the way.

In the long run, proper utilization will result in a stronger profession rather than a larger one. Would not a compact group of the elite command the respect—and financial recognition—that a larger group of jacks-of-all-trades has been unable to attain?

Colin Carmichael

EDITOR



Not all contracts prohibiting subsequent employment with a competitor will hold up in court—but those considered "reasonable" by the courts can be enforced. Here are pointers on how to evaluate the legality of such a contract, and what to look for when making or signing employment-limiting agreements.

DUE to the nature of work involved, it is not unusual for an engineer to be requested by an employer to sign employment-limiting contracts. These contracts place limitations on the type or location of work which the engineer may do if he leaves the company's employment. The general purpose of such a contract is to prevent disclosure of the firm's designs, plans, and similar material to competitors. Employment contracts of this type should be carefully examined by the engineer because of the far-reaching nature of the limitations frequently imposed and by the company to assure adequate protection that is within legal bounds.

The history of competitive-employment contracts reaches back into England over 500 years ago. Membership in the trade guilds of that day was extremely restricted. The employers were very small businesses, frequently merely a craftsman, his shop, and a few workmen and apprentices. Newcomers to the profession were trained in these small shops and it was natural that the employer should wish to protect himself against possible future competition from the people whom he trained. The guild monopoly gradually disappeared before the industrial revolution, and as competition increased, it became of even greater importance to the employer to guard against possible competition from the skills that he might cultivate in his employees.

At that time, the man who was bound to his employer by contract prohibiting subsequent employment in competitive work was, in effect, bound to stay with the employer or to enter a new profession. The guilds and early unions made the latter course virtually impossible, so such a contract could cause considerable personal hardship to the employee if, for one reason or another, he found it necessary or desirable to leave his employer.

Historically, the courts have been inclined to rule against competitive-employment contracts almost up to the present day. Now, however, the courts have taken a more lenient attitude toward such contracts and, providing the contract is of a reasonable nature, will hold it as valid. This evolution in judicial attitude is due to pressures from social, economic, industrial, and transportational changes.

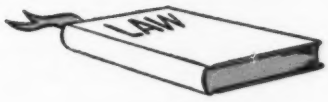
Today, while competition between firms doing the same general type of work is no less keen, the professions have largely lost their old characteristic of secretiveness. A man no longer spends years learning the methods, processes, and solutions of one employer to become a walking repository of relatively secret information that might be of considerable value to competitive firms. With the free flow of technical information that exists, the old fear of losing competitive status due to loss of trained employees has largely died out. This does not mean that employers do not continue to require employees to sign contracts limiting subsequent employment with competitive employers. If anything, the tendency may be on the increase, not because the need for such contracts has grown, but because the general attitude of the courts toward such contracts has changed. The present tendency is to accept the contract and enforce its provisions if they are considered "reasonable."

Definition of "Reasonable"

An Ohio court recently made this observation: "Pounded by the pressures of social, economic, industrial, and transportation change, the law has

Requirements for

Competitive-Employment Contracts



By ALBERT WOODRUFF GRAY
Forest Hills, N. Y.

changed until today as a rough rule of thumb, the law is that a covenant restraining an employee on the termination of employment from competing with his former employer, is valid if it is reasonable in view of all the circumstances of the particular case.

"Such a statement is misleading as over-simplification always is. Reasonableness, like Johnny's being a 'good boy' is complicated. Immediately it breaks down into three divisions and one must consider whether the restraint is reasonable as to (1) the employer, (2) the employee, and (3) the public.

"In determining what is reasonable the goddess of justice that hovers over the American court house with scale in hand has a delicate job of weighing, and it is a three—not a two—pan scale, for she must balance the conflicting interests of employer, employee, and public."[1]

The court traditionally bears in mind the fact that the employer is in a much better position to demand, secure agreement to, and sue for enforcement of a contract than is the signing employee. The same decision quoted before also observed, "Under pressure of need and with little opportunity of choice, he [the employee] is more likely than the seller [employer] to make a rash improvident promise, that for the sake of present gain, may impair his power to earn a living, impoverish him, render him a public charge, or deprive the community of his skill and training. Usually an employee gets no increased compensation for agreeing to the abstention. It is usually based on no other consideration than the employment itself."

Blanket Coverage: An engineer employed by a manufacturer of electrical condensers had agreed, "That he will not at any time during such employment disclose to anyone any information that he may acquire during said employment relating to any of the processes, formulas, plans, circuits, or devices or methods, developed, acquired, manufactured, or practiced at any time by such corporation in its business and he will not use any of said processes, formulas, plans, circuits, devices or methods, or his knowledge of the same except in the course of his employment by the corporation."

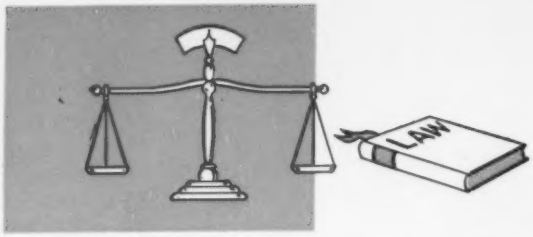
When later this employee joined a competitor, suit was brought for the enforcement of this agreement by injunction. In its refusal to order compliance with this contract, the court pointed out that the scope of the agreement had gone beyond what was a fair protection of the employer.

"It is quite clear that the contract goes beyond the protection of trade secrets and embraces anything that the employee saw or learned during his employment. The agreement given this construction puts a restraint upon the employee's right to labor or exercise his skill greater than is necessary for the fair protection of the employer and therefore such agreement is unenforceable by injunction under the New Jersey law."[2]

An earlier court decision provided a yardstick for measuring the extent of the protection which an employer could secure by contract with its employees. "The test which the law prescribes in all such cases, is this, the restraint in order to be valid must be only such as is necessary to afford a fair protection to the party in favor of whom it is given and not so large as to interfere with the interest of the public."[3]

Overzealous Contract: An employer may make the error of grasping for too much. In a contract

[1]References are tabulated at end of article.



before the Connecticut courts it had been stipulated that for a period of two years after termination of employment for any cause whatever, the employee would accept no employment "within an area of 35 miles from the city of Waterbury."

In holding this agreement unreasonable and unenforceable, the court said, "It is acknowledged that where the task of establishing the maximum legal protection for the employer in contract with an employee, ends, in so far as restraint of future occupational rights of the latter are concerned, and this covenanting becomes overambitious in its encompassment, is most difficult to discern. But when the grasping of too much is evident by the employer, he has forfeited his full rights to such protection."[4]

Typical Reasonable Contract: Contrasted with this instance in which the zeal of the employer had exceeded the judicial definition of reasonableness, is a decision in New Jersey in which the employee had agreed, "that upon the expiration or termination of this contract from any cause whatever the employee agrees that he will not engage directly or indirectly in the business of manufacturing and/or selling any products or devices of the kind or similar to the products or devices at such time being manufactured and sold by the manufacturer or in any way engage in competition with the manufacturer or any agents or managers of the manufacturer, either directly or indirectly as principal or as agent or employee, in the territory and within an area extending fifty miles on either side thereof, during the period of twelve months from the date of termination or expiration."

Here, the restriction was held valid and an injunction issued for its enforcement. "In determining the validity of covenant," said that court, "consideration should be given to the nature of the product and the business of the employer.

"In these days of modern transportation and communication it would appear that with respect to a business of national scope, in the advertisement of which large sums of money have been expended for advertising and goodwill, a covenant whereby an employee agrees not to engage in a competing business for a period of one year within a radius of fifty miles is not to be held, on application for preliminary injunction, so unreasonable as to justify the court withholding relief."[5]

These court decisions outline the general judicial attitude toward contracts limiting competitive employment and show where the courts draw the line between a reasonable and an unreasonable contract. The engineer who has signed such a contract should have its provisions clearly in mind when selecting and accepting new employment and, if the contract appears to fit the court definition of reasonable, bear in mind the possibility of legal action by his original employer.

Damage-Sustained Stipulations

Some employment contracts have provisions that specify the amount of restitution to be paid if the contract is not observed. The courts again apply their definition of reasonable, and enforce contracts with provisions for payment of amounts that represent a fair evaluation of the damages actually sustained by the employer. If the amount stipulated in the contract surpasses what the courts consider to be reasonable, it is usually considered a penalty rather than damages sustained, and the contract becomes void and unenforceable.

An employee in Missouri signed a contract in which he agreed that in case of violation, he would pay the employer liquidated damages of ten dollars per week for the unexpired period of the agreement. Later he entered the employment of a competitor and suit was brought for this agreed amount. In his defense, the employee contended that the clause did not provide for liquidated damages but for a penalty and hence was not enforceable.

The court held the employee liable for these payments. It said, "The true question is whether in view of the actual breach complained of, the sum named in the contract is to be fairly regarded as a penalty or as a fair measure of the real damage in the estimation of the parties most familiar with the probable effects of its breach.

"Certainly the contract states as clearly as words can that it was the true intention of the parties that this should be a contract for liquidated damages. There is no ambiguity about it. There was no fraud, no unfair or improper dealings.

"It is a clear case of businessmen of equal standing and ability and possessed of full knowledge of the situation dealing with each other on terms of equality, providing as best they could against the contingencies and uncertainties of the future. Under such circumstances there is no reason why they should not be permitted to make their own contracts and when they are so made it is the province of the court to enforce them, not to alter them."[6]

However, here again, contracts of this character must be within the judicial definition of reasonable. Beyond the boundary line of that definition they are relegated to the catalog of penalties—void and unenforceable.

Penalty Clause: An engineer agreed in his employment contract that he would not, "while this contract remains in effect or at any time within two years thereafter, enter into the employ of any client of the employer," and that in case of a violation the employer should be entitled not only to an injunction but in addition to the sum of $10,000 as liquidated damages.

"Liquidated damages," said one court, "is a cloak for penalties but calling an outrageous penalty by the more kindly name of liquidated damages does not absolve it from its sin."

The designation of this sum as liquidated damages does not necessarily make it such, rather than a penalty, said the court. "If the provision was inserted for the purpose of deterring the employee from breaching his contract and of penalizing him for doing so, instead of specifying a sum which the parties in good faith agreed upon as representing the damages which would ensue from a breach, it is to be regarded as imposing a penalty.

"The provision under consideration is within this category. In such a case recovery will be limited to the actual damage and if no damage is proven no recovery may be had."[7]

Contract Limits: Over fifty years ago William Howard Taft, later President of the United States, wrote the opinion in a federal-court decision that clearly defined the limits set up by the law beyond which contracts against competitive employment may not go.

"It was of importance that businessmen and professional men should have every motive to employ the ablest assistants and to instruct them thoroughly; but they would naturally be reluctant to do so unless such assistants were able to bind themselves not to set up a rival business after learning the details and secrets of the business of their employer.

"But it would certainly seem to follow from the tests laid down for determining the validity of such an agreement that no conventional restraint of trade can be enforced unless the covenant embodying it is merely ancillary to the main purpose of a lawful contract and necessary to protect the covenantee in the enjoyment of the legitimate fruits of the contract or to protect him from the dangers of an unjust use of those fruits by the other party."[8]

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2. Sprague Electric Co. v. Cornell Dubilier Electric Corp., 62 *F.S.* 1, Delaware, August 7, 1945.
3. Sternberg v. O'Brien, 22 *Atl.* 343, New Jersey, July 16, 1891.
4. Nesko Corp. v. Fontaine, 110 *Atl. 2d* 631, Connecticut, February 19, 1954.
5. Sonotone Corp. v. Hall, 64, *Atl. 2d* 473, New Jersey, March 9, 1946.
6. Werner v. Finley, 129 *S.W.* 72, Missouri, June 6, 1910.
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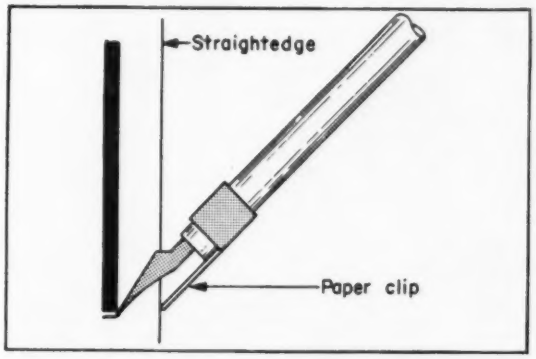
Tips and Techniques

Speed-Ball Inking

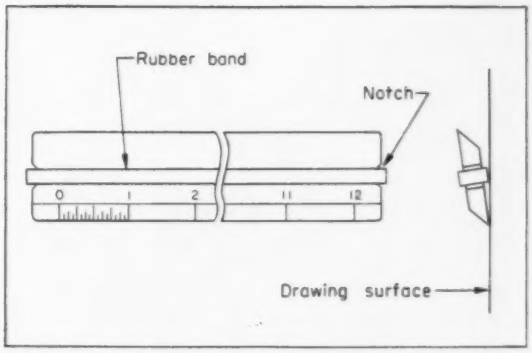
When inking with a speed-ball pen, tape a paper clip to the stock of the pen, as shown. The clip will eliminate taping spacers to straight edges and



triangles to prevent ink smears on the drawing.—WILLIAM G. MYERS, *Weatherhead Co., Fort Wayne, Ind.*

Preventing Scale Slippage

A rubber band, stretched lengthwise around a scale, holds the scale in place on a tilted drawing board and gives slight tilt which gets the graduations closer to the paper for sharper measurements. In addition, the scale is easier to steady with one hand while making sketches, since the scale does



not tend to slip when the pencil is at the extreme ends. Shallow notches retain the rubber band in place.—DEL BASTON, *Clyde, Ohio.*

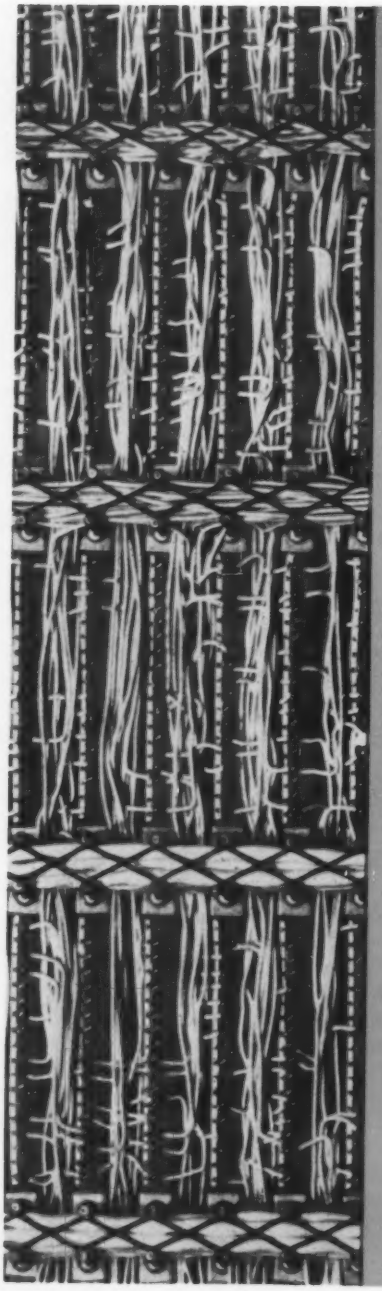
Calculating Shear Modulus

Frequently the specifications for a material give only Young's Modulus for that material. If the modulus of elasticity in shear is required for computations, it can be obtained from

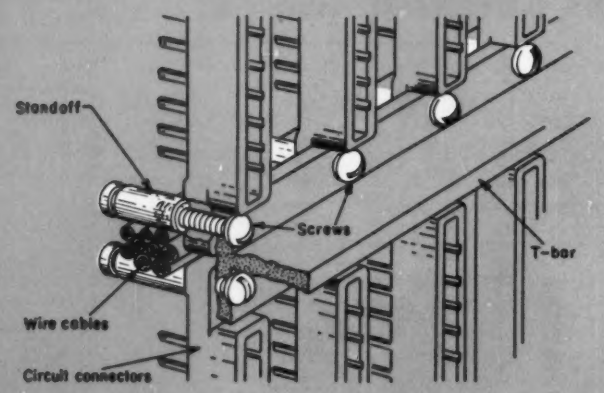
$$G = \frac{E}{2(1 + \mu)}$$

where G = the modulus in shear, E = Young's Modulus, and μ = Poisson's ratio. For metallic materials, usable results can be obtained if Poisson's ratio is assumed to be $\frac{1}{3}$. Therefore, $G = 0.375\ E$.—JOHN E. MAHONEY, *Chevrolet Engineering Center, Warren, Mich.*

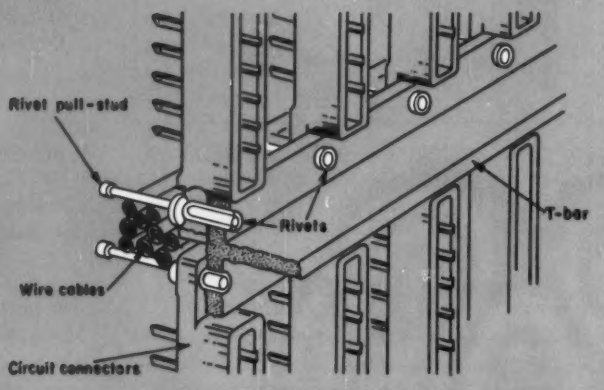
scanning the field for *ideas*



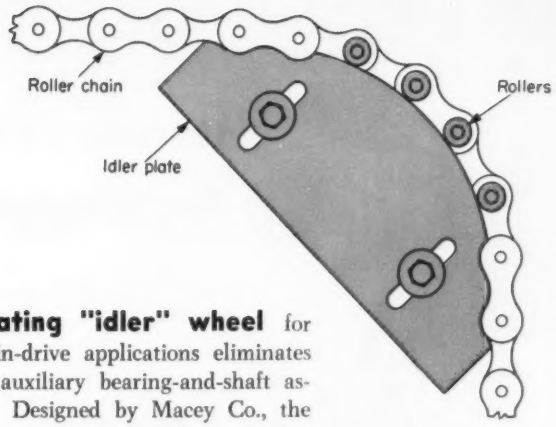
Laced-cord retention of wiring harnesses offers fast, effective solution to assembly problems in complex electronic or electrical circuitry. Developed by Bendix Computer Div., Bendix Aviation Corp., the retention scheme is a novel application for self-plugging blind rivets, replacing former screw-and-standoff assemblies. The special rivet pull-studs, normally removed, are retained to serve as standoffs. Wiring is placed between two rows of rivet studs and cord is laced between the studs to hold the bundle in place.

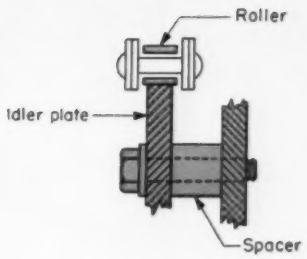


Conventional Assembly



Blind-Rivet Assembly



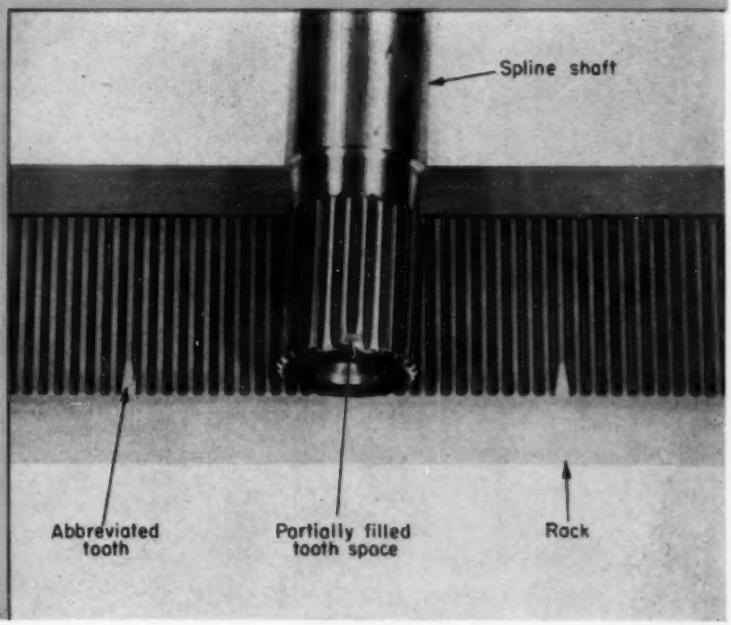


Section

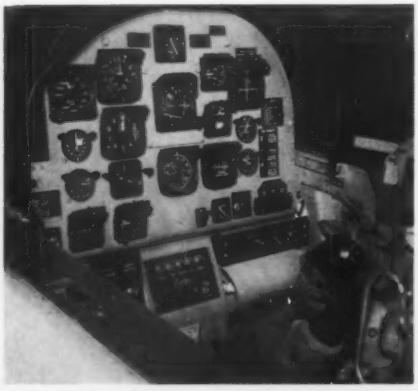
Nonrotating "idler" wheel for roller-chain-drive applications eliminates need for auxiliary bearing-and-shaft assemblies. Designed by Macey Co., the idlers are merely plates with a complete or partially circular outline, fastened rigidly in place. The plate thickness is less than the length of the individual rollers on the chain, permitting the rollers to rotate against the edge of the idler as the chain moves. For takeup-adjustment purposes, the idler mounting holes can be slotted to permit some linear movement.

Exact angular alignment of gear or spline assemblies is assured by partial elimination of tooth space on one member. In a design developed by Michigan Tool Co., two tooth spaces on a spline shaft are left with a wedge-shaped piece of metal at one end. The matching hub has one tooth removed to accommodate each of the missing tooth spaces on the hub. The shaft is produced by rolling, to cold form the spline teeth; the rack has a number of teeth that are tapered at one end so as not to produce a tooth space.

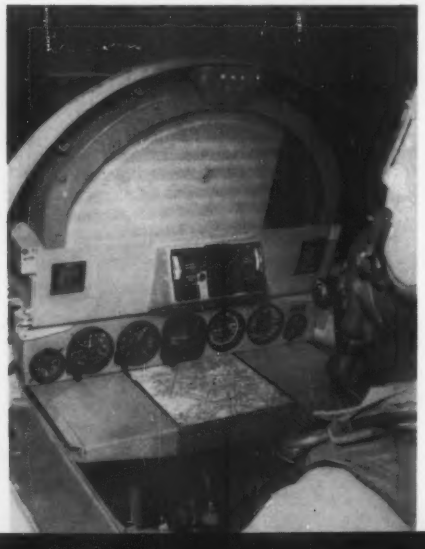
The design may also be used for a gear and rack or for two circular gears. For machined gears and racks, the tooth can be partially removed by machining and the space partially filled by welding.



Classic example of visual-display complexity—in shear volume and variety of information—is the aircraft instrument panel. Simplification presents a continuing challenge to the human-factors engineer. Contrasted here are the standard panel for Navy's T2V-1 jet trainer and a revolutionary display built around a flat-plate television tube. Mounted behind the windshield, the "contact analog tube" gives the pilot a continuous picture of sky and terrain.



Photos, courtesy, Douglas Aircraft Co. Inc.



Human-Factors Engineering—2

CHIEF function of visual displays in a man-machine system is to inform the operator what the machine has done, what it is doing now, or what it is going to do next. Before selecting the display best suited to the job, the designer must first determine answers to certain key human-factors questions: Will the operator require quantitative or qualitative information? How accurate must the information be? What use will be made of it? Must the operator interpret or anticipate the display reading?

With this data in hand, the designer can make a tentative choice of one of four general display types: 1. Counter. 2. Dial and moving pointer. 3. Dial with moving scale. 4. Coded symbols (signal lights, etc.). Each type has advantages and disadvantages which must be evaluated from the standpoint of man-machine efficiency. Pros and cons of each type are noted in Table 1 for a representative design problem—that of selecting an oil-pressure indicator. Comments given are generally valid for any visual-display design situation.

It is extremely important that the designer determine the type of information (quantitative or qualitative) that the operator should have. Display of the wrong information hinders the operator in the performance of his job. A careful systems analysis must often be carried out before this decision can be reached.

Regardless of the type of display selected, two human-factors considerations are paramount: 1. The display must be designed so that the operator can see it under the most critical operating conditions. 2. The display must allow the operator to interpret the information quickly enough to allow him to make the proper decision, or to execute the appropriate control action. Visibility and inter-

Design for Seeing

By JOHN D. VANDENBERG and C. THOMAS GOLDSMITH
Occupational Research Center
Purdue University
Lafayette, Ind.

Chief, Human Engineering Unit
Picatinny Arsenal
Dover, N. J.

pretation of display information are examined in following sections of this article.

Display Visibility

The important conditions influencing the visibility of a visual display are these:

1. Intensity of illumination
2. Size and design of numerals and letters in the display
3. Brightness contrast between various parts of the display and their background
4. Period of time during which display is viewed
5. Angle at which display is viewed
6. Color contrast between display and background

The manner in which combinations of these factors affect the visibility of a display is complex, but design data are being continuously gathered. For example, Table 2 summarizes information on recommended size of fixed and moving characters for use in visual displays that must be viewed from various distances, angles, and under different lighting conditions.

Obviously, for best results, the surface of the display should be placed at a 90 deg angle to the viewer's line of sight. If displays must occasionally

Table 1--Display Comparison for Oil-Pressure Gage Application

Information Type Required	Type of Display: Counter (1 2 3)	Dial plus Pointer	Moving Dial	Coded Symbols
Quantitative--What is the exact oil pressure?	Good	Fair--Depends on scale range and accuracy required	Fair	No good
Qualitative--Is the oil pressure too high?	Poor	Fair--Only if part of an array of such displays	Poor	Good
Qualitative--What is the approximate deviation from desired oil pressure?	Poor	Good--Location of pointer and rate of movement easily seen	Poor--Slower than moving pointer. Hard to interpret without reading numbers	Good--Particularly if three-way code, (e.g., red-green-amber) is available
Setting-in--Operator wants oil pressure to be exactly 200 psi	Fair--Not readable during rapid movement. Easily checked	Good--Close coupling of knob and pointer movement. Avoids overshooting	Fair--Hard to read during rapid setting	Good--Only for showing operator that pressure is at least 200 psi. Poor otherwise

be viewed from angles considerably less than 90 deg, appropriate adjustments in the recommended design features should be made. For example, if dial pointers form a part of the display, they must be placed very close to the reading surface to eliminate parallax errors at acute viewing angles. How visibility deteriorates as viewing angle decreases from 90 deg is shown in Fig. 1. It is noted that the redesigned characters produced fewer errors than the old characters, but the trend is still in the direction of increased errors as viewing angles become more acute and viewing distances increase.[1]

Dial and Pointer Design

General rules that should be kept in mind when designing dials are as follows:

1. Scale divisions should not exceed the inherent accuracy of the instrument giving the indication
2. Scale divisions should not exceed the accuracy with which the instrument must be read
3. Scale divisions should not be closer together than 0.04 in. for the normal maximum reading distance of 28 in.

Minimum recommended dimensions for scale divisions, assuming normal reading distance, are given in Fig. 2.

The manner in which numerical values progress on scale must be considered. Examples of good and poor scale progressions are shown in Table 3.

Improperly designed pointers can be a source of confusion to the operator in a man-machine system. Pointers should be functionally and not artistically designed. There should be no flourishes or arrow tips. Further, the point should just meet, but not overlap, the shortest scale-division mark, and should be of the same color as the graduation marks. When possible, numerals should be located outside graduation marks, oriented so that they are upright when being read.

[1]References are tabulated at end of article.

Counter Design

In many cases, a direct-reading counter (an automobile odometer is an example) has advantages over the dial and pointer. With counters, a numeral height-to-width ratio of 1:1 is recommended, rather than the 3:1 ratio recommended for dials. These proportions accommodate the curved surface upon which numerals are displayed. Other design recommendations for counters are illustrated in Table 4.

Cathode-Ray-Tube Displays

The military has used the cathode-ray tube (abbreviated CRT) in operating situations for many years. Industrial uses of the CRT have been confined primarily to laboratory equipment, although it has proved useful in some industrial and control situations. Information concerning the design of CRT displays is summarized in Table 5.

Warning Lights

It is sometimes unwise to leave the detection of certain critical conditions to the routine reading of a dial or counter. For example, dangerously out-of-tolerance conditions (e.g., excess boiler pressure) and

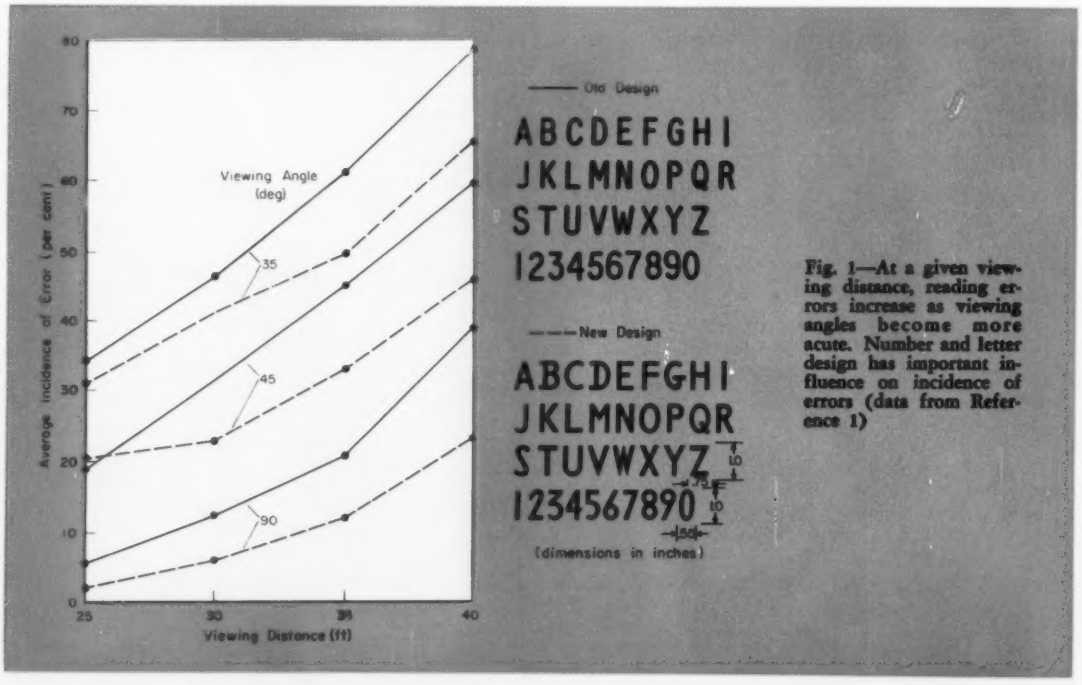


Fig. 1—At a given viewing distance, reading errors increase as viewing angles become more acute. Number and letter design has important influence on incidence of errors (data from Reference 1)

emergency situations (e.g., fire), both requiring immediate action, are preferably signaled by a warning light. Design and placement of these critical displays is an extremely important matter.

Brightness contrast is a factor of vital importance in the detection of signal lights. When illuminated to warn of a special condition, lights should be as bright as possible and should be exhibited against a background of black matte. Although size of the lights may vary within a wide range, a diameter of 0.25 in. has been found useful for many purposes.

Use of color coding may be desirable and, if this is done, the code must be compatible with other color associations the operator may have acquired. For example, green is usually a safe signal, while red means high voltage or fire. Commonly employed color codes are summarized in Reference 2.

Further warning-light design tips which insure prompt action are:

1. If the lights serve only to indicate danger or a very unusual occurrence, they should flash intermittently. The flash rate should be 4 to 8 cps, with "on" time approximately equal to but not greater than "off" time.

2. To avoid confusion in times of stress, it is imperative that lights be clearly labeled, that labels be adequately illuminated, and that wording of the labels clearly indicate what must be done.

3. If feasible, the light should be located on or near the control that must be manipulated.

4. If the control is not near the operator's normal

Table 2—Character Size*

Viewing Distance (ft)	Character Height (in.) Moving	Fixed	Labels
Illumination: Less than 1 ft-L			
Less than 2.0	0.15	0.12	0.05
2.1 to 3.0	0.20	0.15	0.05
3.1 to 6.0	0.45	0.30	0.10
6.1 to 12.0	0.90	0.55	0.15
12.1 to 20.0	1.50	1.00	0.25
Illumination: More than 1 ft-L			
Less than 2.0	0.10	0.08	0.05
2.1 to 3.0	0.17	0.10	0.05
3.1 to 6.0	0.35	0.20	0.10
6.1 to 12.0	0.70	0.40	0.15
12.1 to 20.0	1.10	0.75	0.25

*Dark characters on a light background should be 2/3 as wide as they are high. Stroke width (i.e., width of the line) should be 1/6 the height. For light characters on a dark background, and for transilluminated or phosphor-luminous characters, width should equal height and stroke width should be 1/8 of height.

Table 3—Scale Progressions

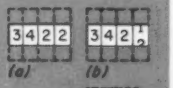
Good				
1	2	3	4	. . .
5	10	15	20	. . .
10	20	30	40	. . .
Poor				
4	8	12	16	. . .
2.5	5	7.5	10	. . .
5	22	75	87	. . .
Provisional*				
3	6	9	12	. . .
30	60	90	120	. . .
1	10	100	1000	. . .

*Some scales (e.g., clocks, compasses,) have "natural" scales which are good when applied to such instruments, but exceedingly poor when applied generally.

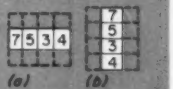
Table 4—Counter Design Recommendations

1. Numerical reading of counter should increase with upward drum rotation.

2. Least-count digit should "snap in," *a*, not "glide in," *b*. Same for other digits if possible.



3. Arrange counter design to read from left to right, *a*, not top to bottom, *b*.



4. Low-count digital displays should preferably show blanks in higher decades, *a*, not zeros, *b*.

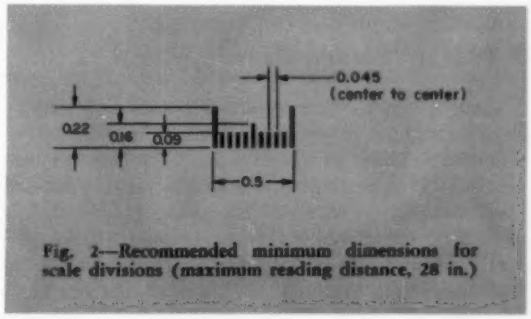


Fig. 2—Recommended minimum dimensions for scale divisions (maximum reading distance, 28 in.)

Table 5—Applying the Cathode Ray Tube

Characteristic	Recommendations
Scope size	May be as small as 5 in. diam when viewed by only one person. May be as large as practicable.
Scope position	Viewing distance should be 12 to 18 in. Perpendicular viewing desirable, although angles of up to 30 deg may be tolerated.
Signal size	Should subtend not less than 1 min of visual angle.
Signal duration	Phosphors persisting up to 0.2 sec may be used if very weak signals must be detected and extreme speed is not important.
Signal brightness	As great as possible.
Contrast	As great as possible with background brightness exceeding 1 millilambert and 0.01 of ambient.
Ambient illumination	Should not reflect from scope face nor excite phosphor. Hooded screens and selective lighting filters can eliminate these effects.

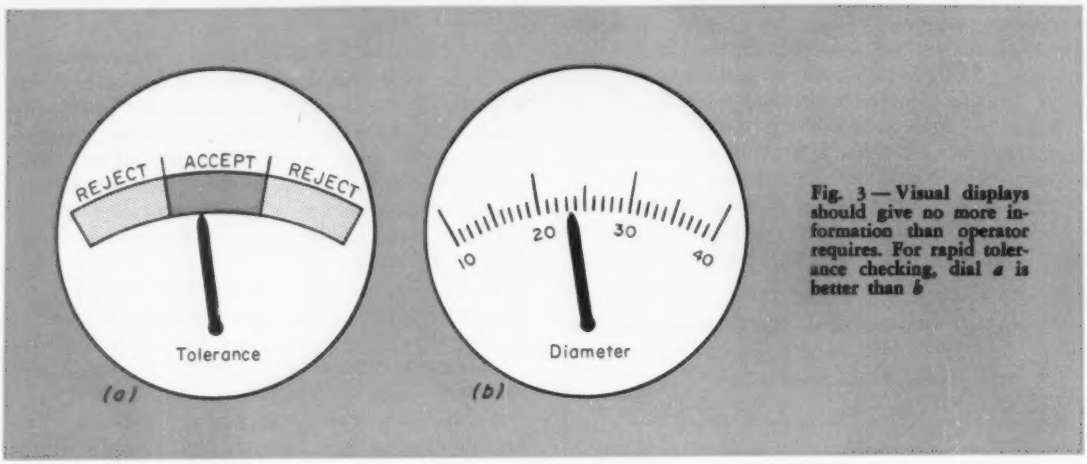


Fig. 3 — Visual displays should give no more information than operator requires. For rapid tolerance checking, dial *a* is better than *b*

line of sight, the light should be placed where it will be seen quickly even though it may not be near the control.

Display Interpretation

Ease of display interpretation is insured primarily by selecting the proper type of display for the design situation. After the display has been selected, interpretation is facilitated if the instrument is labeled and calibrated in terms of the quantity (or quality) that is of direct interest to the operator of the system, rather than in terms of the quantity being measured. For example, if rate of movement is translated to a voltage output by a transducer, the display voltmeter should be scaled to read in feet per second, not voltage. Thus, the operator does not have to convert volts to feet per second.

It is also important that the operator should be given no more information than he needs to do his job. For example, a scale may indicate only tolerance ranges as shown in Fig. 3 rather than precise quantitative values.

Display labels should tell the operator what the instrument is measuring, not what the instrument is. For example, rather than proclaiming *Thermometer*, a label should read *Temperature*. Labels should also be brief. The abbreviation *RPM* is preferred to *Tachometer, Revolutions per Minute*, or *Tach.*

Pictorial-Symbolic Displays

Visual displays discussed so far may be called "symbolic displays." That is, the quantity or quality displayed is symbolic of the factor being measured.

Another type of display, which is coming into greater use, may be called a "pictorial display." This type represents directly and graphically the physical condition that is being monitored. It is most useful where the location of objects in two or three-dimensional space must be represented. Examples are railroad traffic-control boards, radar plan-position indicators, and air-defense plotting boards.

Pictorial displays used to convey information concerning the attitude or location of a moving vehicle may be of two types: 1. They may show the vehicle moving relative to fixed space. 2. They may show space moving relative to a fixed vehicle. Examples of each type are shown in Fig. 4.

In the past, it was maintained that the fixed-space, moving-vehicle display was more easily interpreted. Operational evaluations of such displays have revealed, however, that neither type is universally suited for all situations. Man-machine factors determine which of the two kinds should be used, and an experiment designed for the specific problem at hand provides a reliable guide.

In general, it appears that when the operator is interested in the movement of his vehicle in space, the fixed-space display should be used. The shipboard dead-reckoning tracer is an example. When he is interested in an external object moving about him, the fixed-vehicle display should be used. Radar plan-position indicators or air-defense plotting boards are typical of this type. Interpretation of either type of display is facilitated if the operator faces forward with respect to vehicle movement. The vehicle can be displayed as moving in either a forward or an upward direction, with the intended orientation of the instrument providing a guide.

Pictorial Displays

The flow panel, such as used in oil refineries or power-generating stations, is a combination pictorial-symbolic display. In this type, sensing devices throughout the system give the operator information concerning the state of the process by means of symbolic displays. The various symbolic displays are arranged in a pattern corresponding to the physical location of the processes being monitored. Thus, it is easier to follow the flow (either physically or sequentially) of the material being processed.

Layout of such flow panels should be logical from the operator's viewpoint. For example, reading habits have accustomed the operator to scanning a line of type from left to right. The display should there-

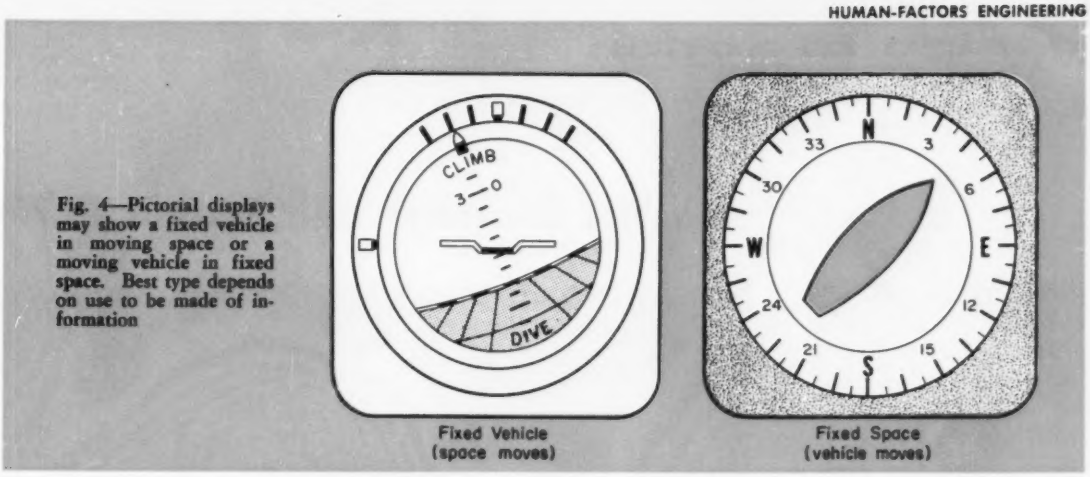


Fig. 4—Pictorial displays may show a fixed vehicle in moving space or a moving vehicle in fixed space. Best type depends on use to be made of information

fore be arranged so that normal monitoring and operating can be done in this fashion.

In the design of control and monitoring stations for exceedingly complex man-machine systems, it may be impossible to locate all instruments in their optimal positions. Paradoxically, this dilemma may be overcome by adding more display elements. For example, warning lights may be arranged in a single panel located near the operator's line of sight. If anything goes wrong at any point in the system, one of the warning lights is activated. This simple attention-getting device gives qualitative information that something is wrong. It also tells the operator where the trouble lies, and he can then quickly check the instrument which gives him quantitative information on which he can act. Obviously, such a warning panel relieves the operator of the tiring task of constantly monitoring a large display area, and insures that he will not miss danger signals.

Work-Area Lighting

There is a great deal of literature concerning the matter of general lighting of the man-machine area. Unfortunately, much of it is controversial. Table 6 shows levels of illumination that have been recommended for various types of tasks.

Table 6—Work-Area Lighting Recommendations

Task	Illumination (ft-c)
Extremely detailed and prolonged work (e.g., inspection of dark yard goods for minute flaws)	100
Precision machine work; detailed drafting; assembly of miniature parts	50
Prolonged reading; general office, laboratory or assembly work	25
No detailed vision; hallways or where some adaptation is required	5

Since shadows and glare from direct lighting have a deleterious effect on job performance and comfort, use of indirect lighting is recommended. Brightness of the area immediately surrounding the work area should be between 10 and 90 per cent of the work-area brightness. Attention must be given to the entire work space, as well as to the immediate work station and the area surrounding it. It is recommended that ceilings reflect 75 to 90 per cent of the incident light, that walls should be 40 to 60 per cent reflective, and that floors should be 15 to 30 per cent reflective. Background of an instrument display should be not more than 30 per cent reflective, and a matte finish should surround critical instruments. Displays should be as bright as the ambient illumination if possible.

Color Coding

Color coding can aid the operators of many man-machine systems, and its use is encouraged wherever possible. Recommendations for such coding have been published,[3] and such codes should be followed to insure that workers will not be confused by a color code different from one already learned.

A note of caution concerning the possible use of operators who may be color defective: Such people are often unable to distinguish between certain reds and greens, or between reds and browns. Colors should be chosen from hues that are detectable by color-blind operators.

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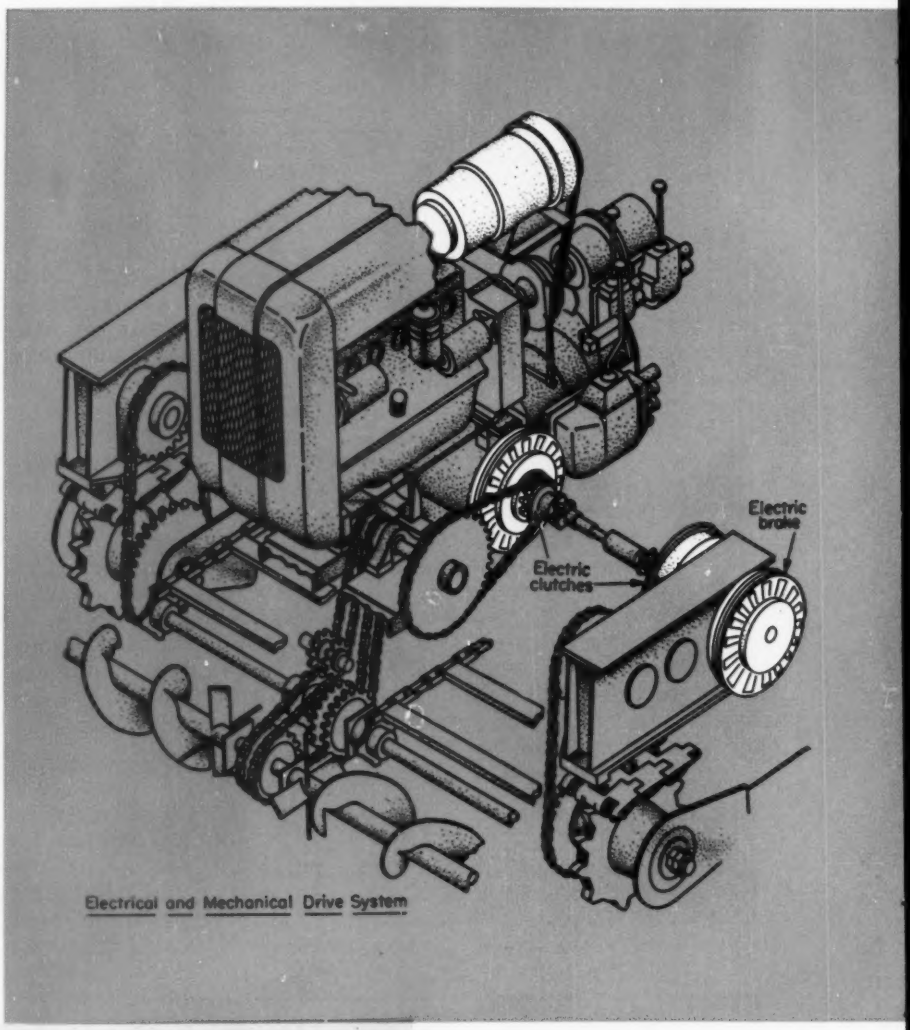
Electric Clutches and Brakes Permit

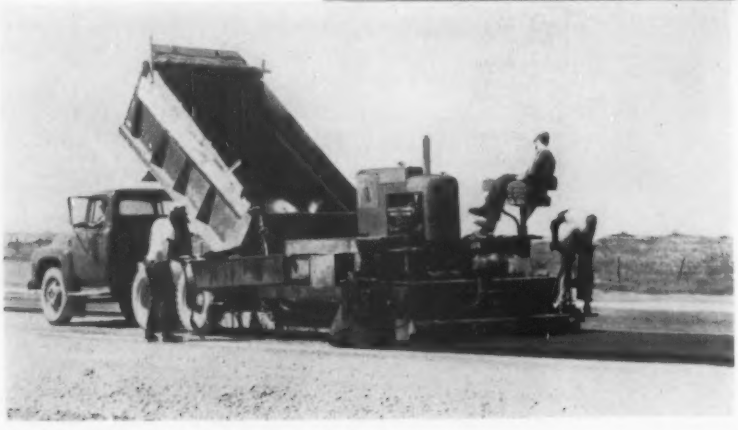
POWER TRANSMISSION for a Cedarapids paver originates from a gasoline or a diesel engine through a main clutch. An 18-speed transmission drives both crawlers and the conveyor spreading mechanism. Simplicity and efficiency of this power transmission system are demonstrated by the fact that only six chains and two V-belts are used, where other similar systems may use as many as 17 chains and 10 V-belts.

Four electric clutches made by Warner Electric Brake and Clutch Co. are provided on the main drive to control the slat-feed conveyors and spreading screws for each side of the unit, and to operate the crawler drive. Clutches engage in approximately 4 millisec. Two Warner electric brakes, one for each crawler, provide simplified maneuvering control by locking crawlers as required.

Conveyors and screws are powered through the 18-speed transmission by chain drives which operate each assembly at speeds synchronized with the crawlers.

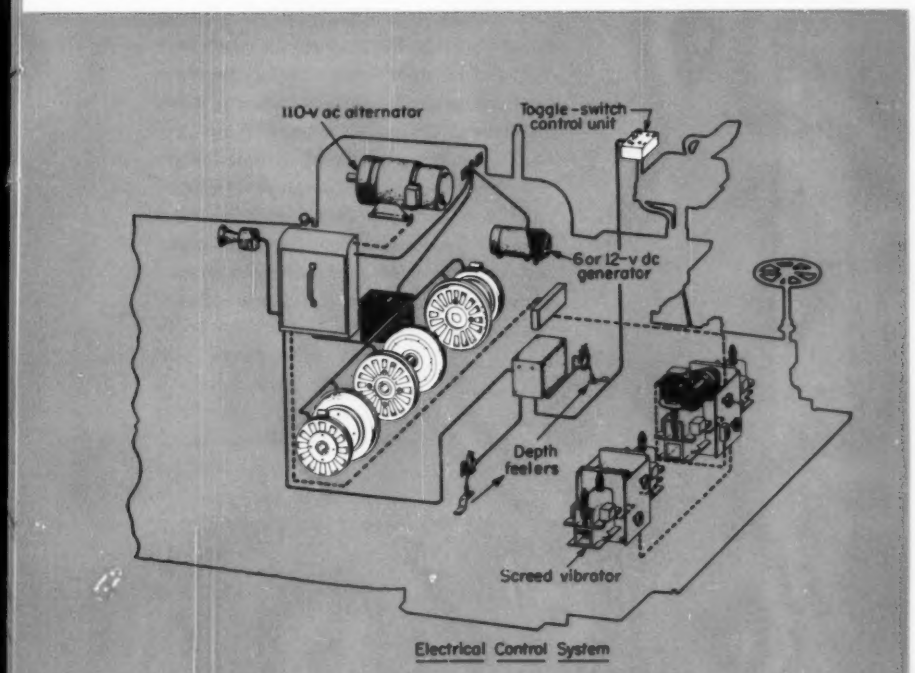


Electrical and Mechanical Drive System



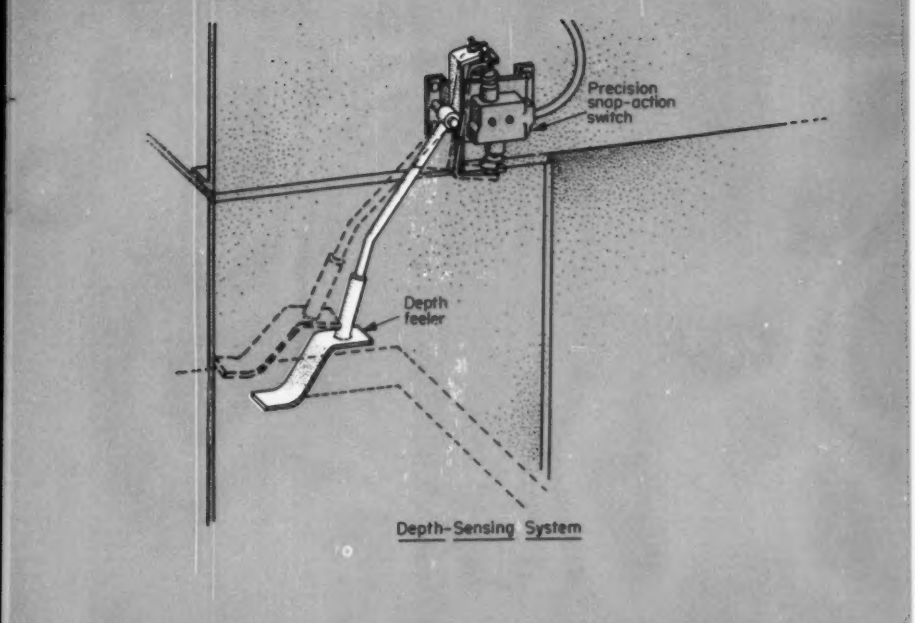
CONTROL SIMPLIFICATION and low maintenance are design advantages claimed by using electric brakes and clutches in this new bituminous paver. The operator controls the clutches and brakes simply by manipulating toggle switches. Designed and built by the Iowa Mfg. Co., the machine has been successfully operated at paving speeds as high as 102 fpm.

Toggle-Switch Operation of Paver



Electrical Control System

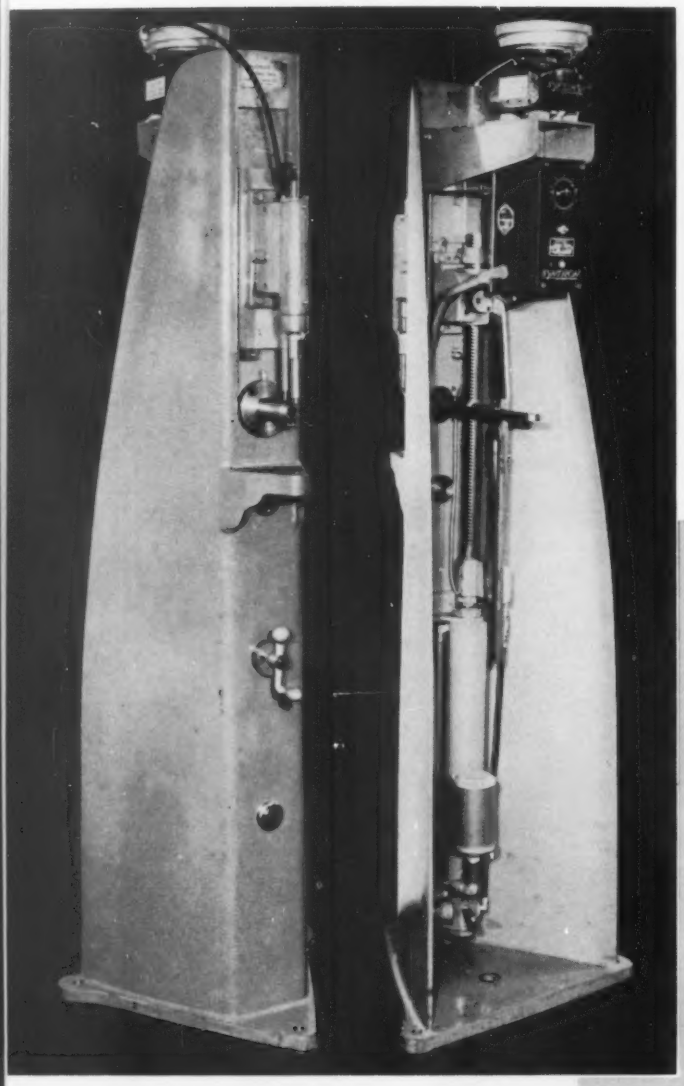
CONTROL VOLTAGE for operating clutches and brakes is provided by a 6 or 12-volt generator driven by the main engine. Power from a 110-volt generator is used to supply either burner, utility outlets, and vibrators.



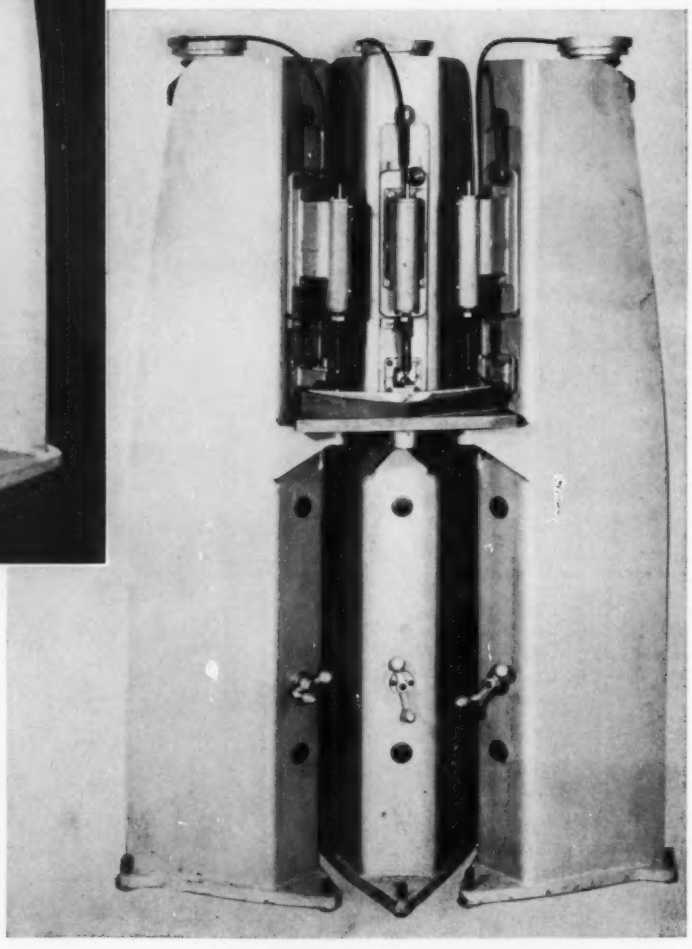
Depth-Sensing System

DEPTH CONTROL is accomplished automatically with a simple sensing system. Depth feelers ride on material in front of paver screws. When depth of material reaches too high a level, the feeler rides up and closes a precision snap-action switch, disengaging the electric clutch which drives the slat-feed conveyors and spreading screws. As the material level lowers, the feeler rides down and opens the switch, re-engaging conveyor clutch. Separate feeler systems are used on each side of the machine.

V-Frame Stud Driver Develops



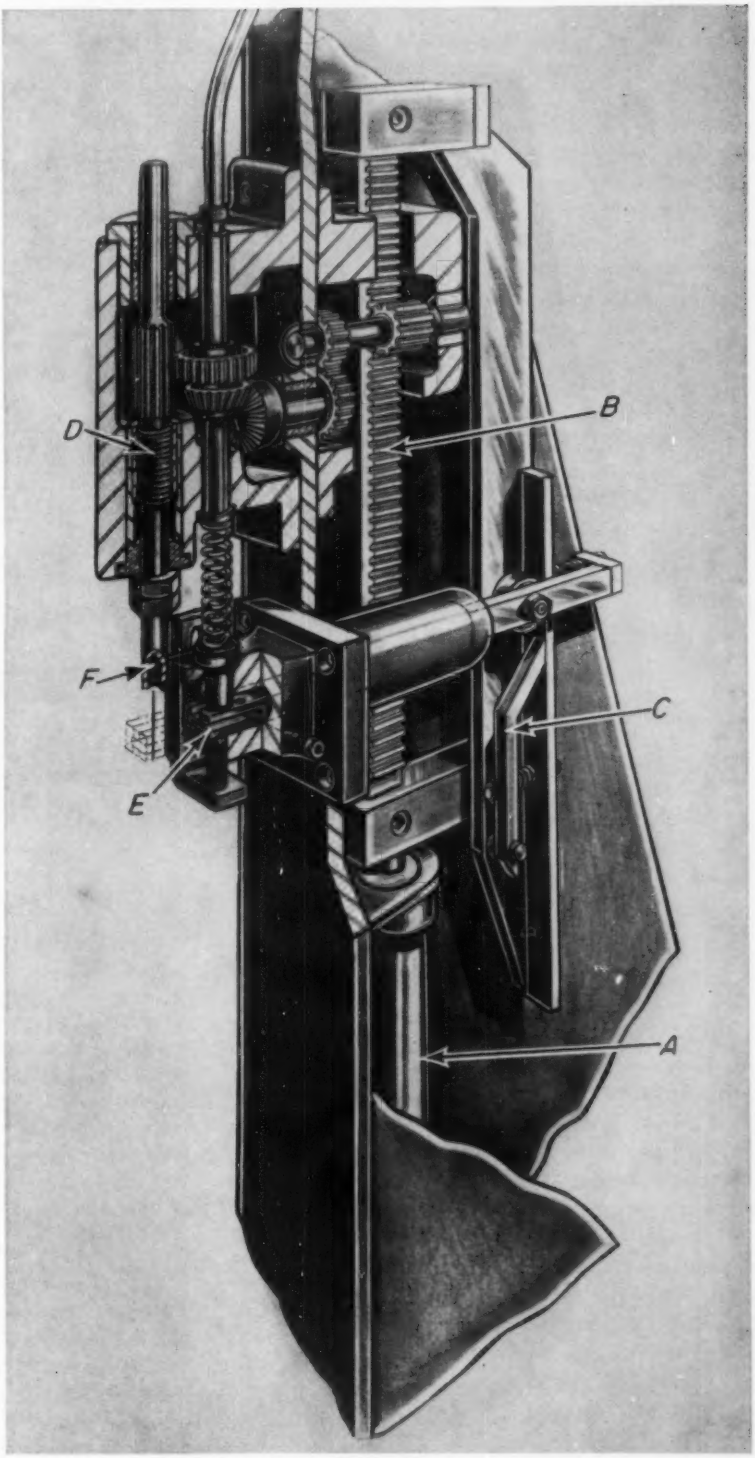
TRIANGULAR CROSS-SECTION of a machine designed by Studrive Inc., Detroit, Mich., to fix studs in die castings permits grouping several such units about a single fixture. Thus the user can "build" a special machine capable of automatically placing as many as eight studs in blind holes in a casting in less than a second. When a production run of a particular casting is completed, the units may be regrouped to handle a completely different casting.



Timed Rotary Forcing Action

ROTARY DRIVING ACTION used in the design of this new stud driver minimizes possibility of stud reaming out the hole rather than threading it. The driving assembly forces the stud into the casting in timed relation to its rotation. This is accomplished through the use of a lead screw which, when rotated, produces a feed movement in accordance with the pitch of the stud. The stud is used as a tap to cut its own threads in the die-cast metal.

In operation, a pneumatic cylinder **A** drives a gear rack **B** and a cam **C** to produce the driving action. The rack powers a lead screw **D** through a gear train to rotate and feed the stud. At the same time, the cam powers a stud-inserting head **E**, which provides a driving head **F** with the stud.



BUILDING BLOCKS or modular construction for electronic circuitry met with stone-wall resistance only a few years ago. Today, there is widespread use of modular packaging techniques for functional circuits. The subject has opened a whole new field of advanced technology to challenge design engineers of all types. It is a field where ingenuity and ability to create must be supported by experience in production methods, with two important objectives—reliability and economic savings.

As more and more electronic equipments are sent aloft and to sea, military requirements become more exacting. Electronic equipment must be reliable to meet increasingly severe environmental requirements. It must be small, light in weight, and economical.

At the First National IRE Symposium on Production Techniques held in June, 1957, Capt. W. I. Bull, U. S. Navy, while assistant chief of the Bureau of Ships for electronics, said, "The following items require careful consideration:

1. **Reliability is the most important factor.**
2. **Production lead time must be reduced to a minimum.**
3. **Economic savings must be obtained.**
4. **Design philosophy must incorporate standardization and modular construction to increase the number of similar end products and to improve logistics."**

Capt. Bull further stated, "Any modular construction should permit easy replacement of modules as required for servicing and maintenance. The modules should be adaptable for short runs as well as long runs of production. The production techniques should be usable by small business with a minimum of set-up time."

These statements a few years ago would have raised doubts. Today they are an accepted expression of what must be done.

This article presents a design approach that produces a highly reliable, shock-and-temperature-resistant modular unit. Encapsulation techniques are covered in detail here so that this step in the process may be better understood.

MODULAR PACKAGING of Transistorized

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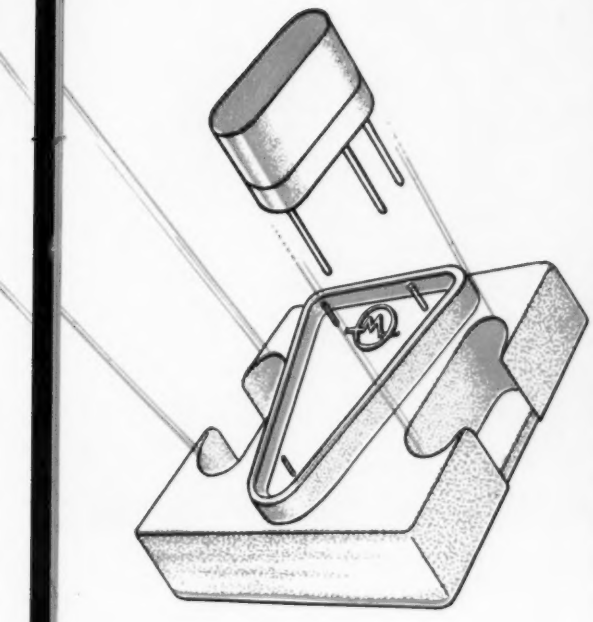
Project Engineers
Melpar Inc.
Falls Church, Va.

THE TREND of modular or building-block construction continues to help make electronic equipment smaller in size and lighter in weight. At the same time, the equipment must be designed to meet the environmental shock and vibration conditions. Since smallness and compactness also intensify the requirements for cooling, the equipment must be designed to handle the problem of heat transfer. General recognition of the cooling problem exists, and will not be discussed.

This article is particularly applicable to the methods of packaging transistorized circuits on printed boards. Of course, most of the techniques presented here for mounting electronic components are also suitable for printed-board application whether the circuits are transistorized or not.

Standardization: Many sizes and shapes of electronic components have been developed over the years for conventional wiring methods, and to meet



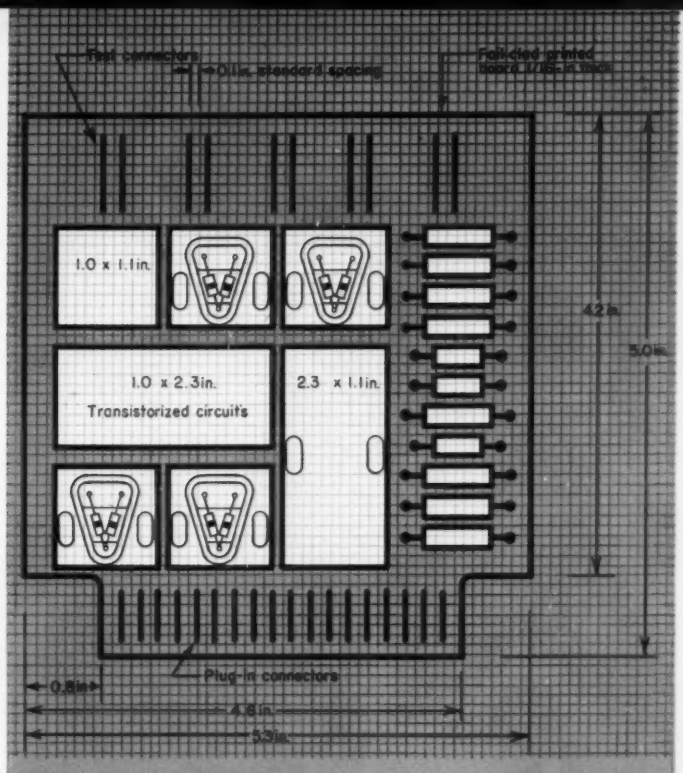


Fig. 1—Engineering drawing of an edge-mounted "printed" board with standardized and unitized modules located on it. Modular subassemblies of various sizes are adapted to the 0.1-in. grid

Circuit Assemblies

. . . to obtain maximum reliability, minimum production time, and cost savings

a wide range of electrical, physical, and material requirements. Unfortunately the great variety of component sizes and shapes do not ease the task of the packaging engineer, the circuit designer, or the component assembler. Of the many types, cylindrical components are unquestionably the most suitable for assembly to "printed" (printed-wiring) boards. They are also the most suitable type of component for machine handling, since they can be classified into standardized categories with respect to body diameter and length. They can be stored on tape or in magazines and do not create a moisture trap.

To meet future needs for components in a field that requires mechanized assembly to be efficient, electronic components must be standardized for both military and civilian equipment applications. Until this occurs the design engineer is confronted with the problem of using many components that hamper efficient packaging of transistorized circuits.

Recognizing the need for standardization of prefabricated boards the Electronic Industries Association (formerly RETMA) established a 0.1-in. grid as a preferred standard. The 0.1-in. grid thus became the first step toward providing the engineer concerned with electronic equipment packaging with discrete standard positions for all parts, whether these components are to be assembled by automatic machines or by manual operations. The 0.1-in. grid does not limit the size of the board or its shape, both of which can vary to meet technical requirements or promotional and sales appeal requirements. It also establishes a framework within which designers of electronic equipment, builders of automatic-assembly machines, and components manufacturers can proceed. At the same time, the freedom of the circuit designer to incorporate new and novel circuit features is not restricted.

Printed-Circuit Boards: As an example of what

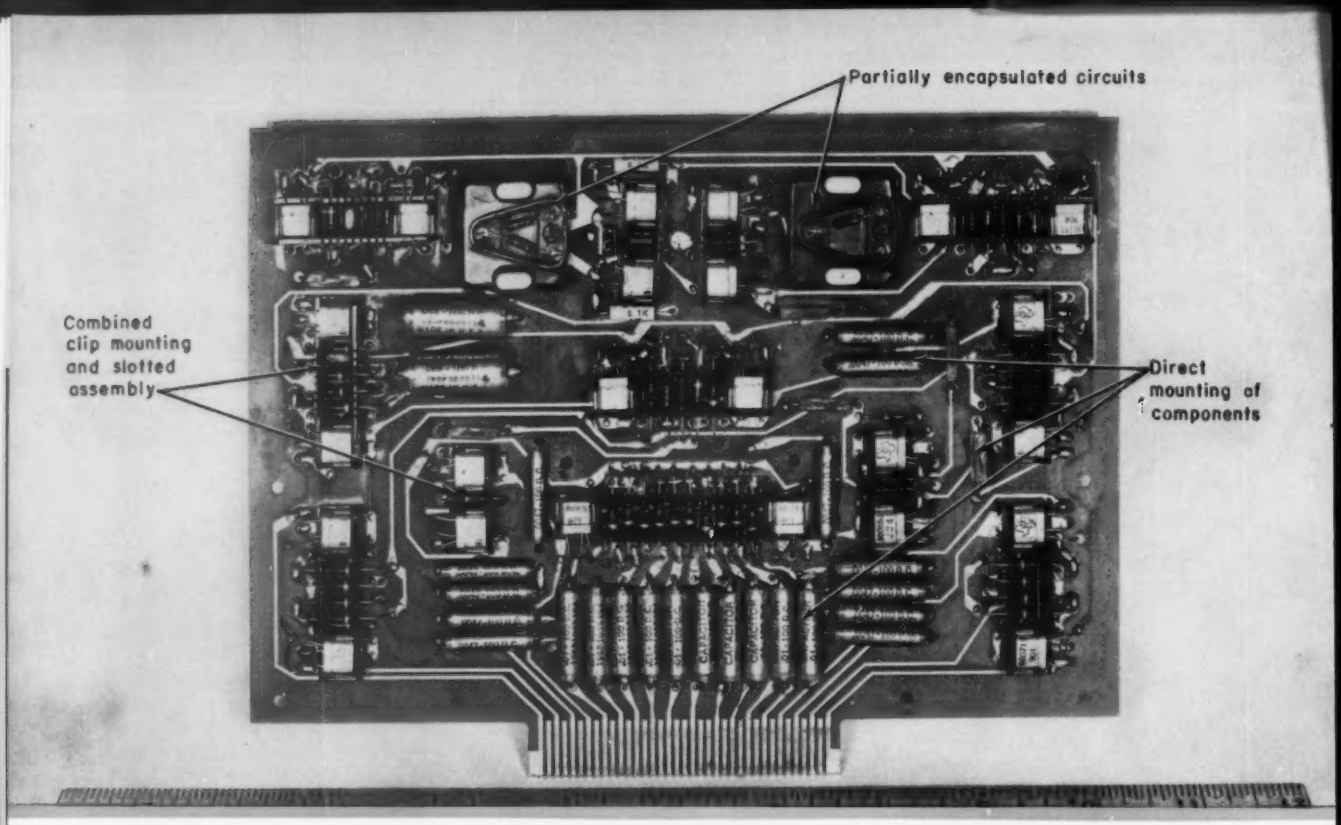


Fig. 2—Plug-in transistorized unit using printed circuitry, partially encapsulated circuits, and combined clip mounting and slotted-assembly mounting of components. Several capacitors are also shown direct mounted

has been done in packaging and standardization, Fig. 1 shows a typical application of standardized and unitized modules on an edge-mounted printed board. It shows modular subassemblies of various sizes adapted to the standard 0.1-in. grid. A sufficient number of these boards can carry a large portion of an integrated network of components. This illustration represents a printed board of very practical size for withstanding shock and vibration; however, it is fully appreciated that no two companies, military agencies, or even circuit designers will want to use this particular standard-size board or any other existing standard board regardless of its size or configuration. Any production technique incorporating standardization, therefore, should permit flexibility in using the most suitable size of board, as well as the greatest variety of components to provide the circuit engineer with design freedom. The design engineer must not be stifled by restrictive standardization limitations.

Use of the printed board for unitized circuits simplifies the assembly process. It facilitates dense packaging of components and mechanization of the assembly and soldering* operations. Packaging requirements for unitized circuits obviously vary with respect to their functional, physical, and environmental use.

Potted Circuits: Functional units or component networks, Fig. 2 and 3, can be developed and standardized for use in many types of equipment. They eliminate repeated routine design detail and require only basic interconnecting wiring. They are replaceable and, since one unit will fit several equipments, over-all inventory levels are reduced. These units are particularly adaptable for military application when potted or encapsulated. They can be built using the grid system and can be "plugged-in" or soldered to the board with the input and output terminals fastening them to the board. On encapsulated units, selected components such as transistors or diodes can be added after encapsulation.

When the input and output terminals are used as a means of fastening the modules to the printed board, a multiple-point soldering tool, Fig. 4, must be used; otherwise it would be impossible to unsolder the module to remove it from the printed board. The use of a single tool with all soldering points determined by the 1/10-in. grid eliminates the need for a special iron for each and every module having a variety of terminal locations. To insure contact with all terminals, the points on the soldering iron are spring mounted. The need for precision fabrication heightwise of soldering points and module terminals is thereby avoided. Encapsulation, clip mounting, and slotted and cellular assembly were needed to attain the reliability, packaging density and resistance to shock and vibration that these modular units represent. These features are also incorporated in the design of modular units, such as those in Fig. 2 and 3.

Encapsulation by any of a number of methods provides an excellent means for obtaining dense

*A. A. Lawson, P. E. Ritt, and H. K. Hazel—"A New Automation Technique for Soldering Components to Foil Clad Boards," *IRE Convention Record, Vol. 4, Part 6, Manufacturing Electronics*, 1956.

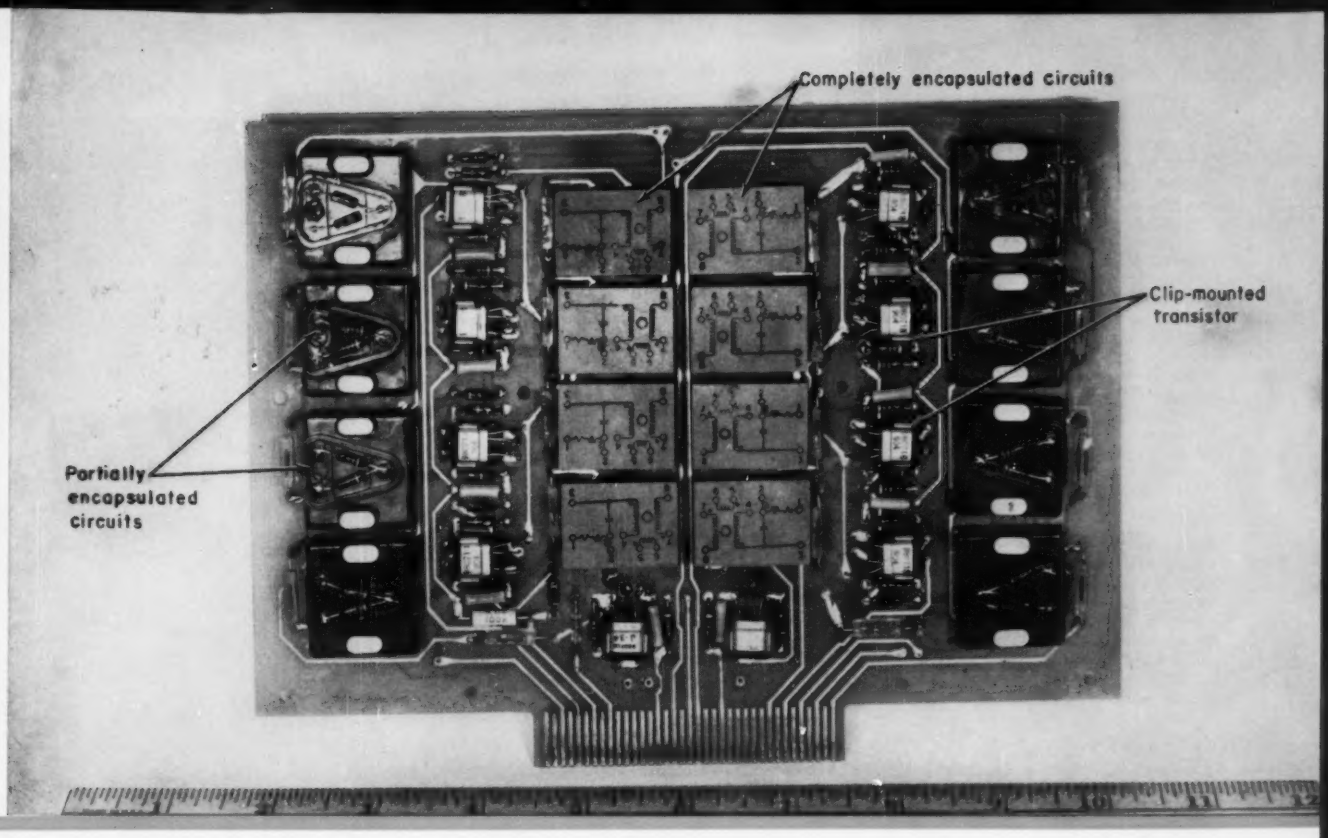


Fig. 3—Plug-in transistorized circuit board using partially and completely encapsulated circuits. Transistors are clip mounted

packaging of components and support under severe environmental conditions. Many engineers avoid the use of encapsulation because they don't know the technique. While it does require detailed methodizing, the result is an end product having the highest degree of reliability in both mechanical and electrical performance. Encapsulation techniques do not require expensive equipment, the process actually being accomplished by means of a simple, inexpensive bench device. This article illustrates the simplicity of the process using a multivibrator circuit and packaging the necessary components. This particular circuit shows how it was possible to encapsulate all of the components with the exception of the diodes and the transistors. These should be mounted on the unit in such a manner that they could be salvaged or, if necessary, replaced.

There are two principal methods of encapsulation —casting and pressure molding. The pressure method is reviewed here; the casting method is discussed in detail after a general description of materials used, a definition of terms, and comparisons of each method are given.

Encapsulation by Pressure Method: Pressure-molding techniques involve forcing a compound around the components to be encapsulated and, through pressure and heat, producing a solid form. In most pressure-molding applications, compounds which were found to be of greatest practical use are those materials requiring very low temperatures and pressures. However, such low-pressure molding materials lack sufficient adhesive qualities to bond themselves to the printed board—a quality needed to provide a hermetically sealed unit. In addition, the forces encountered in the mold can be too much for fragile components even at low pressure. A method, which in some applications might eliminate these disadvantages and still retain the desirable qualities, is to partially precast the subassemblies. This method will hold the less-rugged components in place and protect them from deformation under pressure.

In applications where high production rates and cost considerations are paramount, pressure molding is quite suitable. It takes only 2 or 3 minutes, affording an advantage over casting with resins, which takes much longer. Two advantages are immediately apparent: 1. The complete elimination of trimming. 2. The use of semiautomatic machines. If pressure molding is used, the compromise method of partially precasting fragile components offers the best possibility. This method increases total encapsulation time but will eliminate machine trimming and retain a controlled uniformity of the end product. Components are available that will stand pressure-molding techniques. However, the processes of ruggedization for individual components presently result in too large a final product to encapsulate in the small modular units in Fig. 2 and 3.

At present, therefore, the use of pressure molding techniques is limited where fragile components are concerned. Mass production of parts, such as the slotted-assembly and cellular-assembly units described later, probably represents the best application of pressure-molding techniques in high-per-

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Among his many assignments at Melpar, Mr. Lawson directed the development of the Mini-Mech System for automatic assembly of electronics components to printed circuit boards. He has directed projects involving the design of projectile and rocket fuses, portions of missile systems, and radar antennas.

He is active in IRE, EIA, and the Armed Forces Communications and Electronics Assoc.

J. D. SVEDLOW (right) joined Melpar in 1950. He has a broad background of experience in all phases of electronics, having previously been a project engineer at Edo Corp. and an electronic engineer at Fairchild Engine and Airplane Corp. Mr. Svedlow was a radio repairman in the U. S. Army and, prior to that, worked in electronics at Erie Proving Ground, the Navy Dept., and Micamold Radio Corp.

At Melpar, Mr. Svedlow has been engaged in design and development of a flight simulator, target programmers, and data reduction, conversion, and recording systems. He is also a member of IRE.

formance, subminiature circuits.

Encapsulation by Casting: To encapsulate by casting requires the making of a mold, inserting the mounted components, sealing the mold, preparing the resin, pouring the resin into the mold, curing the casting, removing the mold, and trimming the casting. Many materials can be used for molds. The authors have used Teflon and low-melting-point alloys such as Woods metal. The most suitable material used by the authors to date is Hysol type 3110, a vinyl-chloride compound made by Houghton Laboratories. Use of Hysol permits more freedom in the design of the casting mold, which is made from a metal form. The reason for this freedom is the flexibility of the Hysol material which releases itself from the metal casting form very readily even when the form has slight protrusions.

There are two basic types of curing agents used with resins for encapsulating assemblies by the casting process—agents requiring elevated temperatures for curing, and room-temperature curing agents. The term "pot life" refers to the length of time the resin has a suitable viscosity for pouring after the curing agent has been added to it. In general, "long pot life" and "short pot life" can be defined as: Resins using room-temperature curing agents are said to have a short pot life at room temperatures; resins using elevated-temperature curing agents are said to have a long pot life at room temperatures.

For intricately shaped castings, resins with long pot life are desirable because bubble formation is minimized at the casting temperature. In applications where appearance is not an important factor and where bubbles can be tolerated to gain greater production, resins with short pot life may be suitable and acceptable. After extensive study and investigation, a series of modified epoxy resins were developed. These Melpak resins have variable pouring viscosities, pot lives, and curing times that fit the requirements described herein quite well.

During the encapsulation process, the casting mold and the subassembly must be held in a suitable position to insure minimum bubble traps and to facilitate pouring. In this application it has been found expedient to preheat the mold, resin, and the subassembly before pouring. This procedure lowers the viscosity of the resin, affording less resistance to the escape of bubbles by way of the sprue.

Casting Form: After the shape of the casting is determined, a metal form is made from which the mold is cast. The casting form, Fig. 5, is smooth and highly polished. It is slightly oversize to allow for shrinkage of the mold. In use it must be kept free from surface film and defects, inspected frequently, and polished if there is any evidence of film. The mold is made by mounting the casting form in a curing box, as shown in Fig. 6, and covering the form with liquid Hysol. Fastening the form to the curing box prevents the Hysol from flowing under the form and allows the form to be removed for polishing.

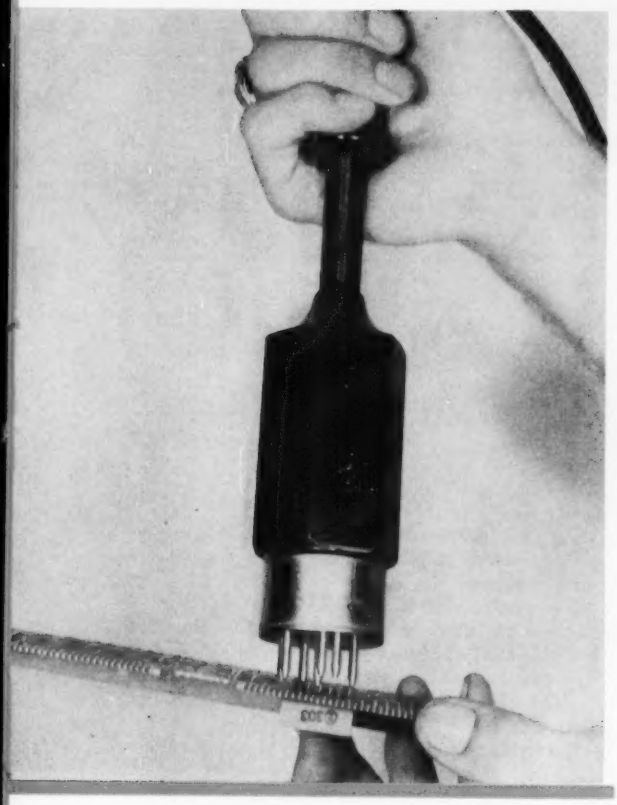

Fig. 4—Special soldering iron for multiple soldering on a 0.1-in. grid circuit board

After the casting form is in place the steps required are:

1. Pour type 3110 Hysol over the casting, drain and then repour until the casting form is a layer of material from ¼ to ⅜ inch thick.
2. Release trapped bubbles by tapping the curing box on a flat surface.
3. Cure the Hysol mold for 25 to 35 min at a temperature between 174 to 180 C and allow the unit to cool to a temperature at which it can be comfortably handled by hand.
4. Carefully extract the Hysol mold from the curing box before it cools to room temperature.

Fig. 7 shows the resulting mold. It should have the sprue cut out with a sharp knife after the mold has cooled to room temperature.

Preparation of Components: Preparation of the assembled components for insertion in the mold involves coating all components and placing an insulation strip over the holes for the transistor connections, Fig. 8. This strip prevents the three eyelets from shorting out on the base of the transistor case. It also eliminates casting this thin strip. Holes are drilled for the transistor leads at the time the transistor is added to the unit. The three tallest posts fit into the holes made by the casting form, Fig. 5, and are the terminals for the externally mounted diodes.

The following steps of preparation are required:

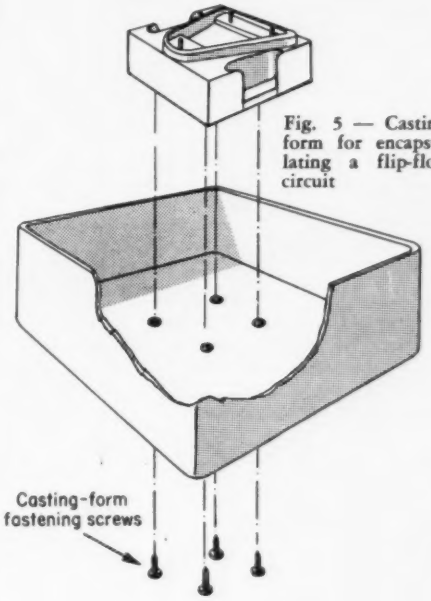

Fig. 5 — Casting form for encapsulating a flip-flop circuit

Fig. 6 — Method of mounted casting form in curing box

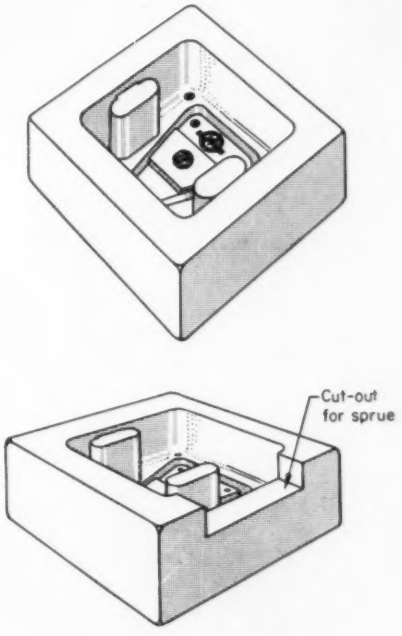

Fig. 7—Hysol mold after casting form and curing box are removed. Mold is shown before and after the cut-out is made for the sprue

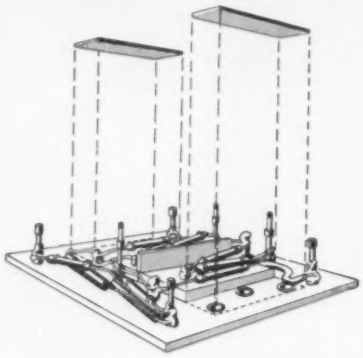

Fig. 8—Preparation of assembly board for insertion in mold

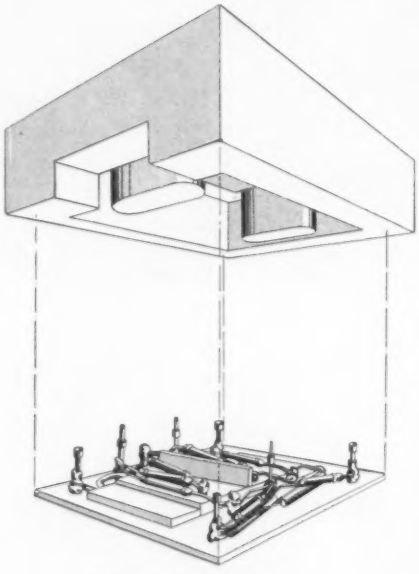

Fig. 9—Position for placing assembly board in mold

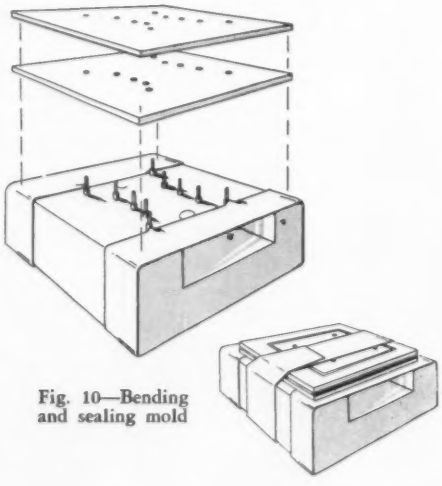

Fig. 10—Bending and sealing mold

1. Thin Silastic 123 with chlorothene to a consistency that can easily be applied with a brush.
2. Apply a coating of the thinned Silastic 123 to the components and repeat until all components are covered. The coating on top of the resistors mounted over the glass capacitors should be about 0.005 in. thick.
3. Allow the Silastic to air dry for 30 min between applications and complete drying of the final coat at 60 C for a minimum of 6 hr.
4. Clean off all excess Silastic from the component board, the eyelets and the three tall terminals.
5. Place a piece of 1/64-in. thick epoxy-glass laminate over each of the two groups of three eyelets as shown in Fig. 8. Use Polyweld 912 as adhesive to hold the strips in place.

Assembling the Mold: The next step is placing the assembly board in the mold and preparing it for casting.

1. Carefully place the assembly board in the mold, Fig. 9. The three tall terminals fit into recessed holes, and the insulation strips rest firmly on the form for the transistor cavity.
2. Coat the exposed side of the component board and the exposed top surface of the mold around the board with Peelac L256. Be sure to cover the pins and seal the junction between the component board and the mold. Do not allow the Peelac to seep into the mold cavity.
3. Dry thoroughly by heating to 60 C for 15 min.
4. After drying, tape the sprue end of the mold and the end opposite the sprue with two turns of ½ in. drafting tape, Fig. 10. Do not distort the mold by tight taping.
5. Recoat the top of the mold and the component board with Peelac. Give close attention to sealing the tape to the mold and dry by heating to 60 C for 15 min.
6. Add two base plates or the equivalent in thickness to fit over the pins and bind the mold with two turns of ¾ in. drafting tape, Fig. 10.
7. Heat the mold assembly for 2 hr at 60 C in preparation for addition of the potting resin.

Preparing Potting Resin: While the mold assembly is heating to facilitate the process of casting, the resin can be prepared. This is graphically shown in Fig. 11, and involves the following steps:

1. Weigh the proper amount of Melpak V resin and metaphenylene diamine (curing agent) in separate containers and bring to a temperature of 66 C.
2. Pour the metaphenylene diamine into the Melpak V while stirring to obtain a thorough mixture. The ratio of mixture is 100 parts by weight of Melpak to 12.2 parts by weight of metaphenylene diamine.
3. Vacuum for 2 min in an atmosphere of 5 in. of mercury.

Casting: Having completed the 2 hr preheating period the mold is placed in a rack designed to allow maximum escape of bubbles from around the components. The rack designed for this unit is shown in Fig. 12 and illustrates the escape route of the bubbles.

1. Pour the resin into the preheated mold, allowing it to enter slowly down on the side of the mold in a thin stream to reduce the formation of bubbles. Be sure the resin partially fills the sprue.
2. After pouring, vacuum the mold for 4 min at an atmosphere of 5 in. of mercury in the position illus-

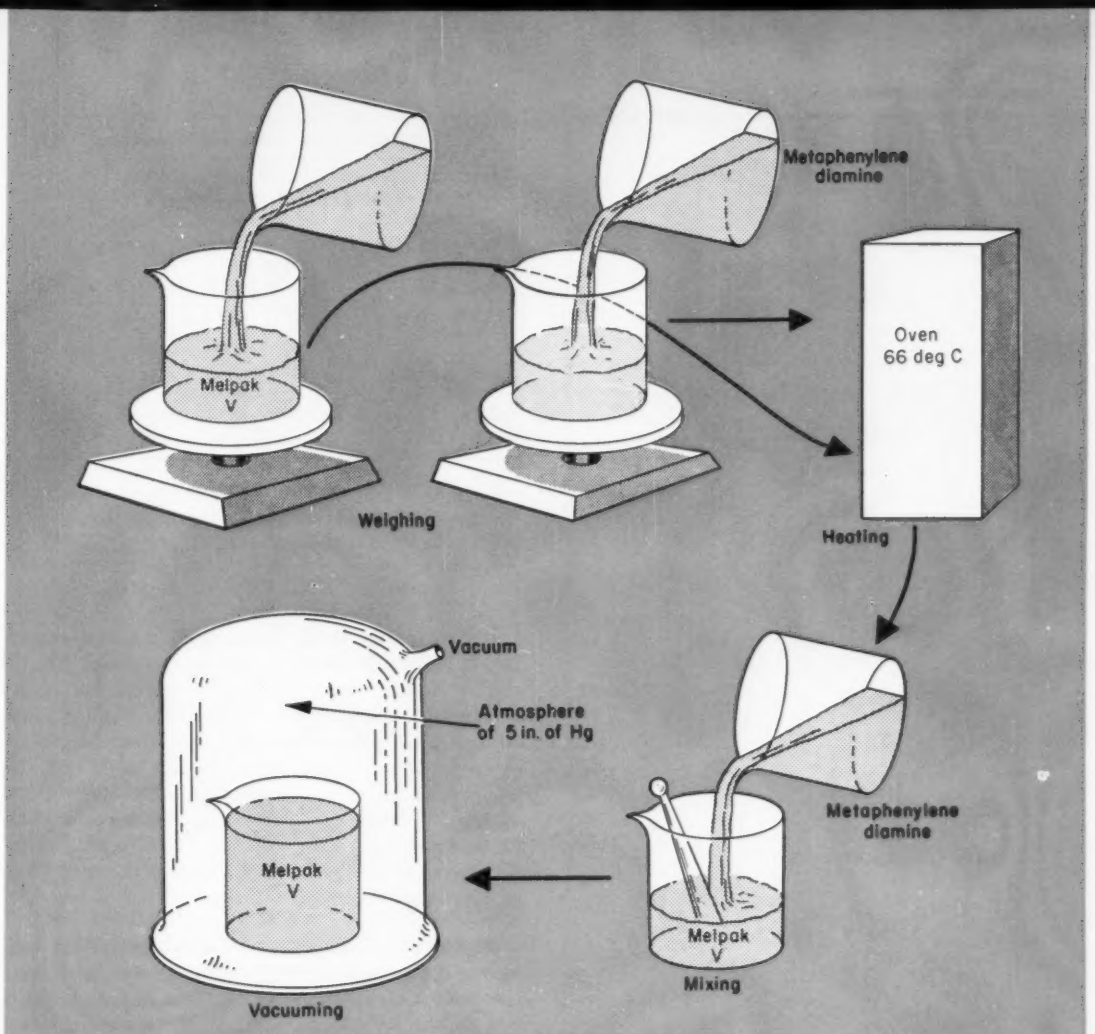

Fig. 11—Preparation of resin prior to pouring

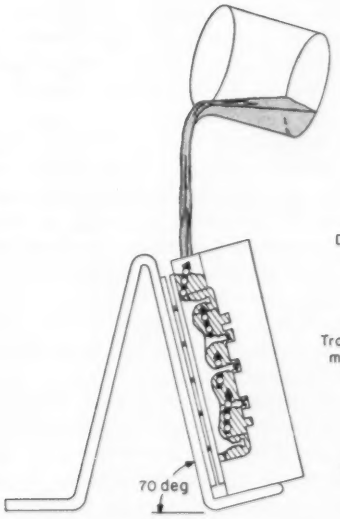

Fig. 12—Recommended position of mold for pouring, showing escape route for bubbles

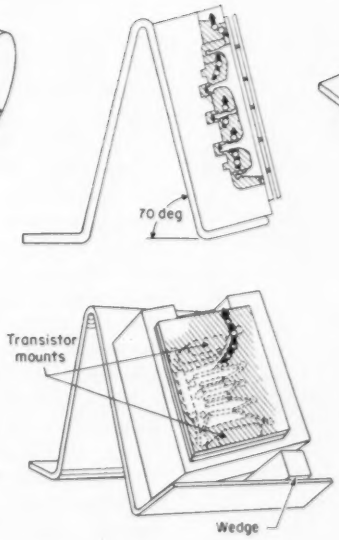

Fig. 13—Escape route for bubbles during vacuuming

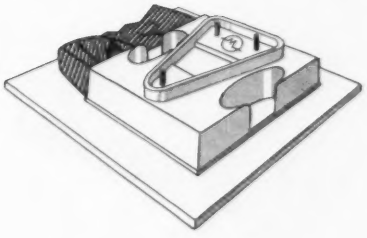

Fig. 14 — Encapsulated unit before trimming

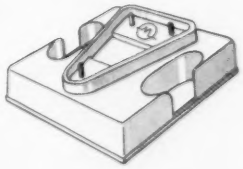

Fig. 15 — Encapsulated unit after trimming

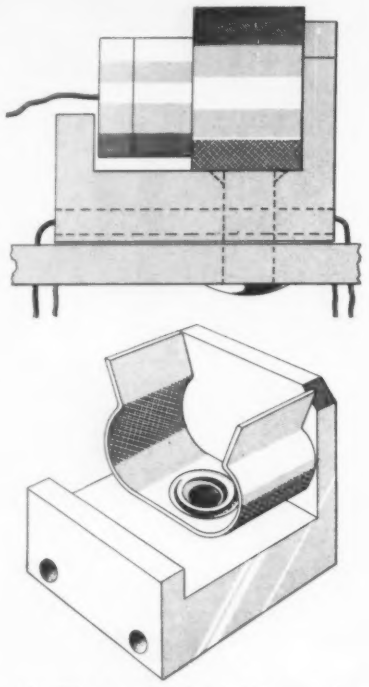

Fig. 16—Clip assembly for holding transistors

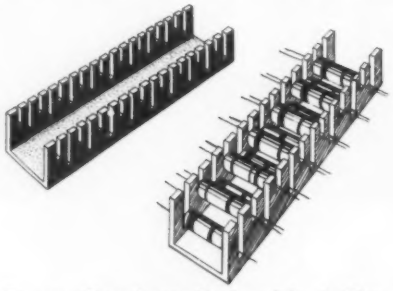

Fig. 17—Slotted assembly board for holding electronic components

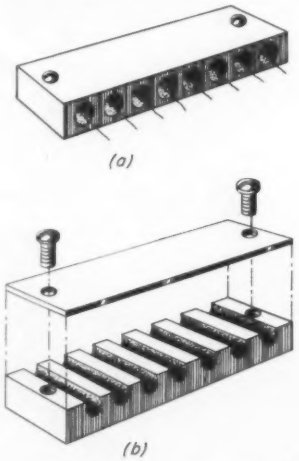

Fig. 18—Two cellular assembly designs for packaging electronic components. In the design shown in *a*, components must be inserted in the holes, whereas the components can be laid in the *b* unit.

Encapsulation Materials References

Curing Agent: meta-phenylene diamine	General Aniline and Film Corp. 435 Hudson Street, New York 14, N. Y.
Resin: Melpak V	Melpar Inc., Falls Church, Va.
Adhesive: Polyweld No. 912	American Phenolic Corp. Chicago, Ill.
Peelac, L 256	Andrew Brown Paint Co. Laurel, Md.
Chlorothene	Leidy Chemicals Corp. 920 S. Eutaw St., Baltimore, Md.
Silastic No. 123	Dow Corning Corp. Midland, Mich.
Hysol type 3110	Houghton Laboratories Inc. Olean, N. Y.

trated in Fig. 13*a*. Note that this is reversed from the original pouring position to bring the bubbles left in the casting off the surface.

3. Cure the poured mold at 71 C for 4 hr with the mold maintained in the position shown in Fig. 13.

Removing the Mold: Approximately 5 min of cooling is sufficient before removing the mold. Fig. 14 shows the unit with the mold removed, but before the sprue is trimmed, the three diode leads cleaned, or the base plate removed. After these steps are accomplished the final unit appears as in Fig. 15.

This process gives a unit that with the addition of transistors and diodes is ready to take its place in modular units like those in Fig. 2 and 3. Uniformity of end product depends upon the care given to sequential steps set forth here.

Slotted and Cellular Assemblies: There is no limit to the application of plastic techniques in packaging component parts. In module boards in Fig. 2 and 3, two other techniques were used to obtain dense packaging and resistance to shock. These were the transistor clip, Fig. 16, and the slotted assembly, Fig. 17. In this application they were used in combination; they may be used individually too.

The transistor clip is mounted in a plastic base and seated against a rear wall. The front of the base has a lip that prevents the transistor from sliding forward out of the clip under vibration and shock.

The slotted assembly is cast or pressure molded in the shape shown in Fig. 17. This design makes the components easily accessible yet holding them firmly in place. With slotted assembly techniques the parts can be easily assembled or disassembled and are much more densely packaged than if mounted directly to the printed board. The use of combination clip and base has economized the use of printed board space by allowing components to be mounted directly below the transistor.

Multiple-layer packaging techniques can be expanded beyond those presented here to more fully obtain maximum density of components by utilizing the space above the printed board. An additional method, although not used in the illustrated board, is the cellular assembly, Fig. 18*a*. The modified cellular assembly, Fig. 18*b*, allows easy access to the components. Both can be stacked to obtain the desired density. Cellular construction can also be potted for further support and, to a degree, "seal in" the components.

Essential Properties of

NYLON TUBING

for pressure applications

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For satisfactory performance of nylon tubing in pressure applications, the inherent characteristics of the nylon should be compared to those of conventional tubing materials.

Data in this article are intended to acquaint designers with properties necessary to qualify nylon pressure tubing, performance and installation characteristics, and specification criteria.

NYLON tubing is being used successfully in a variety of applications which require conveyance of liquids or gases under pressure. It compares favorably in performance with metal tubing and, in many instances, has proved more economical than conventional tubing systems.

Because methods of installing nylon tubing and performance characteristics are different from those associated with metal tubing, the significance of inherent characteristics of the nylon must be understood since nylon pressure tubing is often subjected to flexing, and mechanical abuse.

Properties required to qualify pressure tubing are burst strength, flexibility, impact resistance, cold-brittleness temperature, melting point, and uniformity of structure.

Burst Strength: The naturally high tensile strength of nylon provides high burst-pressure per unit weight and encourages use of nylon in flexible tubing applications where reinforced tubes were previously required. Sizes of two types of a polyamide pressure tubing are shown in Table 1. Short-time burst-pressure values are based on tubing containing 2½ per cent water which is the moisture content of the

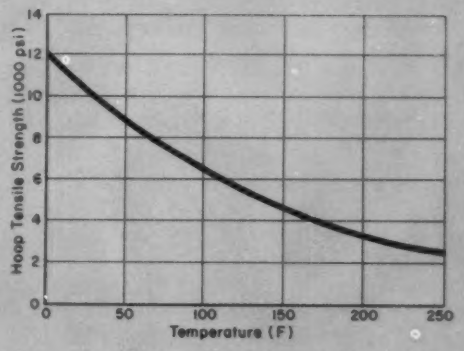


Fig. 1—Effect of temperature on hoop tensile strength of dry Nylaflow tubing. Values of hoop tensile strength are used to calculate short-time burst pressure at unusually high temperatures

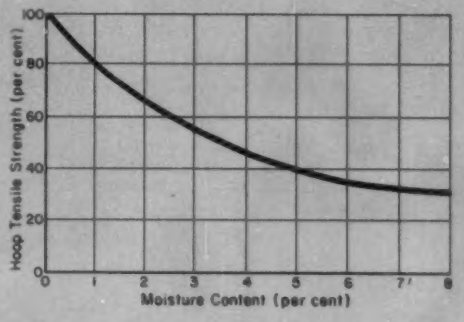


Fig. 2—Effect of moisture content on hoop tensile strength of dry Nylaflow tubing. Hoop tensile strength is shown as per cent of dry tensile strength value of the polyamide tubing

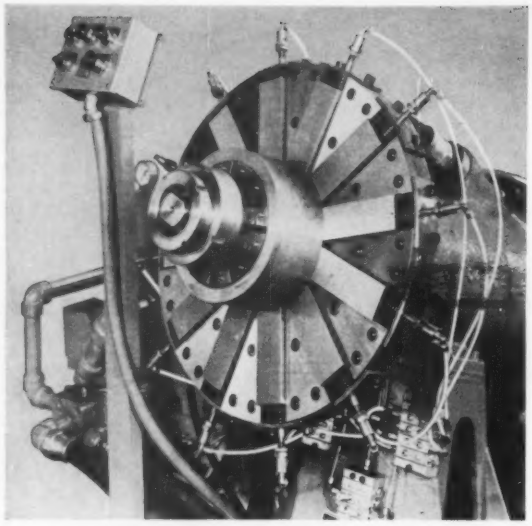


Fig. 3—Nylon pressure tubing in forced-lubrication application on a hydraulically operated metal expander. Constant flexing during 18 mo of operation at 400 to 600 psi caused no indication of failure of any kind

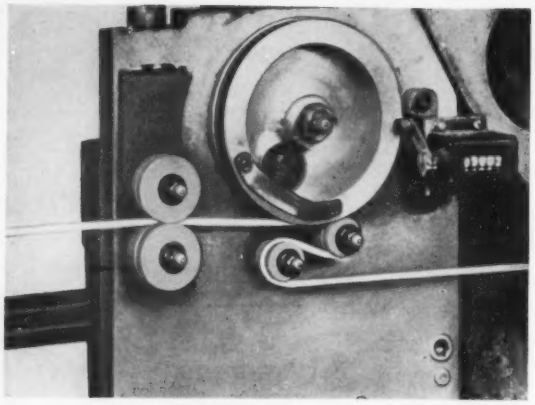
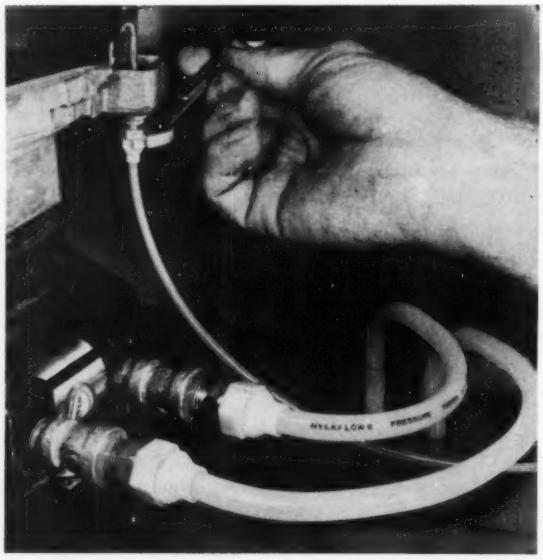


Fig. 4—Above—Roll-bend test developed to detect random brittleness in polyamide pressure tubing. Roll diameters vary with size and type of tubing. Space between rollers is twice the diameter of the tubing. Linear speed of tubing around the rollers is 200 fpm

Fig. 5—Below—Resilient nylon flare nut for use with standard metallic body fitting. Properties of nylon pressure tubing permit cold flaring to standard SAE angles. The nylon nut can be heat cycled to 300 F without leaking and will not shear the tubing if overtorqued



material at equilibrium at 72 F and 50 per cent relative humidity.

Actual short-time burst pressures may be calculated from

$$P = \frac{2\,st}{d}$$

where P = burst strength, psi; s = hoop tensile strength, psi; t = tube wall thickness, in.; and d = tube ID, in. Values for hoop tensile strength for various temperature and moisture conditions are shown in Fig. 1 and 2.

Because of polyamide's high flexural and mechanical strength, a factor of safety from 4 to 1 (lower than for many other types of tubing) has been suggested for many applications. However, it must be recognized that long-time burst ratings are lower than short-time values. Testing for particular applications is recommended to determine effects of temperature, moisture, length of time under pressure, bend radius, and frequency of flexing.

Polyamide tubing exhibits good resistance to diametral expansion under pressure. Nylaflow type H (high burst strength) tubing increased in OD from 0.253 to 0.258 in. when subjected to a pressure of 1000 psi for 48 hr.

Fatigue Resistance: Nylon tubing does not work harden as metals do, and exceptional flex life has been recorded for many applications. For example, 6 and 8-mm OD type H tubing showed no sign of failure when flexed more than 1½ million times while pressurized at 700 to 1000 psi. This tubing was positioned with a bend radius of 4¾ in. while one end was flexed linearly over a 3-in. span at 2½ cps. In a lubrication application, Nylaflow polyamide tubing withstood over 100 million flex cycles without failure.

Fatigue from vibration has been eliminated in many applications by nylon tubing because its plastic properties damp vibrations. Fig. 3 shows ¼-in. OD nylon tubing in a forced-lubrication application.

Abrasion and Impact Resistance: Nylon tubing has unique abrasion and impact resistance and can be expected to perform well where these properties are required. However, tubing should not be used in contact with sharp-edged objects which can notch the wall.

Because of its resilience, nylon tubing deforms only slightly when subjected to an anvil impact of 32 ft-lb, while copper tubing is completely crushed by the same impact.

Corrosion and Chemical Resistance: Nylon tubing contains no plasticizer and will not embrittle in

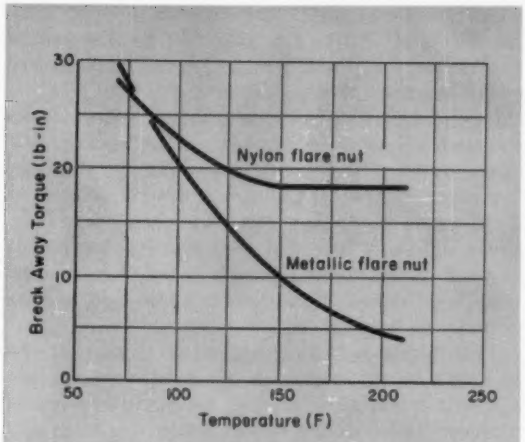


Fig. 6—Comparative retention of breakaway torque of ¼-in., 45-degree nylon and metallic flare nuts after temperature cycling for a minimum of 30 min

storage. It has excellent resistance to a wide range of organic solvents and acids, and is unaffected by aliphatic and aromatic hydrocarbons. It can be used with a variety of lubricating and hydraulic fluids including the highly corrosive, nonflammable synthetics. Because the tubing is odorless, tasteless, nontoxic, noncorrosive, fungus-resistant, and steam sterilizable, it is being used in many food and beverage processing applications.

Polyamide tubing resists alkalis to pH 11 and exhibits excellent resistance to neutral salts. However, it is readily attacked by mineral acids below pH 5 and by oxidizing agents such as silver nitrate, and concentrated chlorine and fluorine water solutions. Continual operation in direct sunlight is not recommended.

Hot water, above 150 F, has a detrimental effect on nylon tubing. Although water at room temperature does not have any short-time effect on the tubing, nylon is not recommended for continued service in water lines.

Temperature Limitations: Nylaflow pressure tubing retains the strength of the basic polyamide at elevated temperatures and has a high modulus of elasticity. Tubing of this formulation has outstanding resistance to creep which permits successful use with standard metallic fittings.

The tubing has a sharply defined melting point in a rather narrow temperature range somewhere around 500 F. Useable temperature varies from −100 to 225 F. Cold-brittleness tests show that properly processed tubing will not fail at −100 F. Virtually all other plastic tubings or formulations become extremely brittle at temperatures well above −100 F. The tubing is subject to heat oxidation, however, and constant exposure to temperatures above 180 F in an oxidizing atmosphere results in embrittlement.

Specification Criteria: Random brittleness and stress crazing are characteristics which cannot be tolerated in nylon pressure tubing. Nylon's crystallinity is responsible for elevated-temperature characteristics which are completely different from those of other thermoplastics, and proper formulation is necessary although somewhat difficult. A good degree of uniformity is necessary for satisfactory performance, and several tests have been developed to verify this quality.

A quality-control roll-bend test, Fig. 4, requires that tubing pass around rollers of varying diameters at the rate of 200 fpm. In addition, a nondestructive proof pressure test requires that 100 per cent of the polyamide tubing be subjected to approximately 70 per cent of rated short-time burst pressure. A bend-radius test requires that pressure tubing be wrapped around a mandrel a minimum of two times without kinking or becoming oval. Mandrel diameter is twice the minimum bend radius of the tubing.

It is assumed that the smaller the bend radius of a tube, the greater the resultant flex fatigue due to fiber stresses. Although complete data are not available, there is indication that flex life can decrease markedly if the radius for continued flexing is less than 10 times the OD of the tubing. For example, a ⅛-in. OD nylon tubing would probably exhibit reduced life when repeatedly flexed with a bend radius under 1.25 in.

Standard Tube Fittings: To seal a tube at a fitting connection it is necessary to stress the tubing wall. All thermoplastic materials, including polyamides, have a low modulus of elasticity which decreases inversely with temperature and moisture content. Polyamides are superior to other thermoplastics in their combination of properties relating to applicability of fittings, i.e., a modulus of elasticity of approximately 275,000 psi, a compressive strength of approximately 12,000 psi, and a heat distortion temperature of 180 F. These properties give the tubing the ability to take a cold flare.

A modified flaring tool, with a spreader angle of 120 degrees, to allow for springback of the nylon, will produce 45 degree flares. A standard metallic plumbing tool with a 90 degree spreader angle is satisfactory for producing 37 degree flares. The tool must be bottomed when forming the flare to prevent orientation of the tubing by excessive pressure. Metallic flare fittings withstand temperature cycling to approximately 140 F before leaks develop while compression fittings can be cycled to approximately 180 F.

If nylon tubing is used under average conditions, most metallic fittings can be used successfully. In applying fittings, overtorquing must be avoided to prevent cutting the flare. Fittings which require a "bite" into the tubing are not always recommended since long-term performance characteristics of these fittings have not yet been determined.

A new nylon flare nut, Fig. 5, for use with a standard metallic body can be heat cycled to 300 F without leaking. When stressed, this resilient nylon nut compensates for flow tendencies of the tubing

but will not shear the tubing when overtorqued. The nylon nut reduces the tendency for the fitting to shake loose under severe vibration. Fig. 6 shows comparative retention of breakaway torque of the nylon flare nut after cycling for a minimum of 30 min at a given temperature.

Compression fittings are more successful if an internal metallic mandrel such as a roll pin is inserted into the end of the tube at the point of compression. A rubber compressing ring is recommended for most applications.

Application Advantages: Nylon tubing is lightweight (specific gravity 1.4), is easy to handle in coil form, and is easily cut with a sharp knife to produce clean, square ends which require no deburring. However, pruning shears, saw blades, or regular metal-tubing cutters should not be used. Special hand cutters are available for low-volume application, and production cutting can be performed by automatic equipment.

Inherent flexibility of the tubing provides for installation economy by eliminating prebending, flexible couplings, and intermediate fittings. Standard fasteners, clamps, or holders are used to control installation on various types of equipment. Polyamide tubing is firm and does not bend as readily as most of the familiar flexible tubes, but its minimum bend radius, Table 1, is small enough to cover virtually all applications.

The tubing is translucent which makes it easy to detect foreign matter or air bubbles in the system, but is readily colored for coding or appearance purposes. Other design factors which should be considered in the selection of polyamide tubing are the electrical insulating qualities inherent in basic nylon, low surface-friction characteristics, sound-deadening characteristics, and thermal insulating properties.

Table 1—Nylon Pressure-Tubing Sizes

Short-Time Burst Rating (psi)	Tubing OD (in.)	Tubing ID (in.)	Min Bend Radius (in.)
1000*	1/8	0.096	5/8
	3/16	0.138	1
	1/4	0.190	1 1/4
	5/16	0.242	2
	3/8	0.295	3
2500†	1/8	0.078	5/8
	3/16	0.110	5/8
	1/4	0.150	1 1/4
	5/16	0.188	2
	3/8	0.225	2 1/2

*Nylaflow, type T. †Nylaflow, type H.

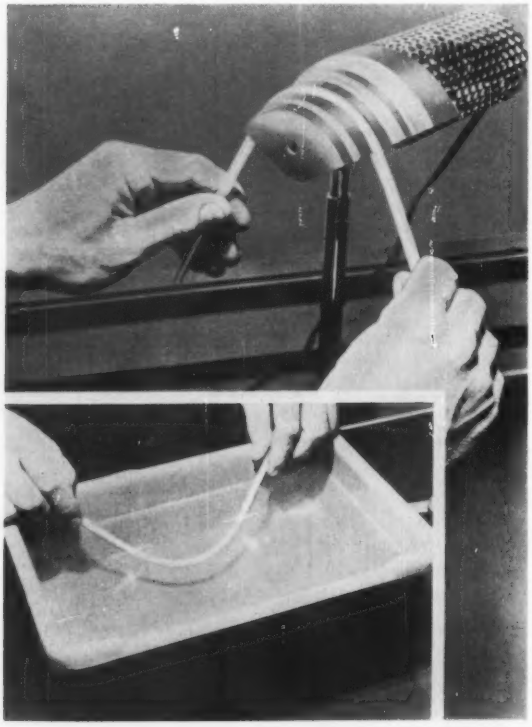


Fig. 7—Tube bending device consisting of heating element and grooved mandrel for nylon tubing sizes to 3/8-in. OD. Tubing is heated for 10 to 20 sec, bent to shape, and cooled in water. Controlled heat prevents tube surface melting

Prebending: Nylon tubing can be permanently prebent to shapes required in rigid assembly applications to obtain performance characteristics of the actual assembly. A device of the type shown in Fig. 7 consists of a heating element and grooved mandrel which accommodates tubing sizes to 3/8 in. OD. The tubing is heated for 10 to 20 sec, bent to the required radius and angle, and cooled by immersion in water. Mandrel heat is controlled between 400 and 435 F to prevent surface melting of the tube.

Another method of holding a bend in the tubing is by means of a tube-bending clip. This clip is used to bend 1/4-in. tubing 90 degrees to a 1-in. bend radius. The clip is flanged at both ends for snap-fastening to the tubing, and can be easily removed and relocated.

They Say . . .

"There are too many instances in this country today where qualified men are starved for junior assistants or adequate tools and are used on work which less qualified men could do. There are many cases where a team of 5 or 6 qualified engineers is doing work which could just as well be done by one first-class engineer given an adequate supporting staff of technicians."—Sir George H. Nelson, *president, Institute of Electric Engineers.*

"The time lag between scientific discovery and its first practical application has been greatly shortened. The long lag between the basic work of Maxwell, Hertz and others and the development of electric power and radio communication has been telescoped to a few years."—Morrough P. O'Brien, *dean, College of Engineering, University of California, Berkeley, Calif.*

SPRING DESIGN CHARTS

Part 2—Compression Springs

By H. J. BOLL
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Charts and procedures for a simplified approach to design and standardization of extension springs were presented in a previous article (April 17 issue, Page 137). In this article, details of a companion approach developed for compression springs are given.

DESIGN charts for compression springs can be developed in the same general manner as for extension springs. The one major difference is that compression springs are not wound with initial tension.

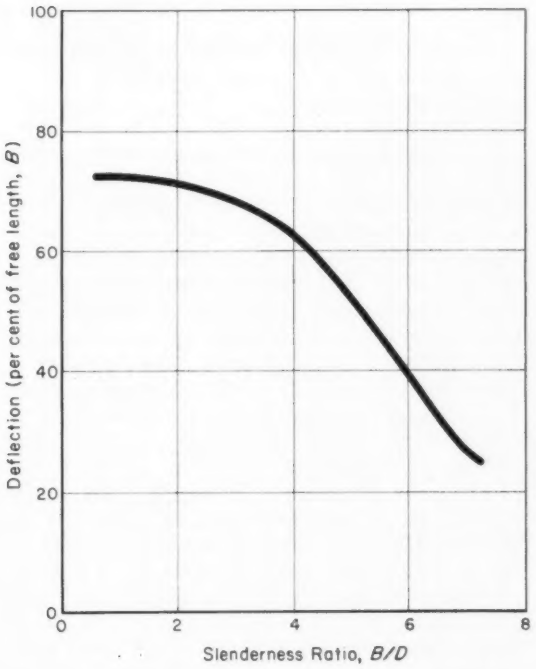


Fig. 6—Buckling characteristics of compression springs. Curve plot represents limit condition. Points above curve indicate that spring will buckle; points below are safe.

The charts presented here have been developed for a series of compression springs which will be stressed to 120,000 psi when compressed solid. This value is approximately the maximum allowable stress for music-wire compression springs. These springs cannot, therefore, be overstressed; another step toward standardization.

Compression springs usually are made with "closed" or "squared" ends to improve seating characteristics and minimize buckling. Free length B of these springs includes one "dead" coil at each end for squaring. Thus, active length of the spring will be less than free length by an amount $K = 2d$ (symbols are defined in Nomenclature). Number of active coils, then, is

$$N = \frac{B - K}{L} \tag{16}$$

From the fundamental relationships for helical round-wire springs (Equation 1 of previous article),

$$f_{max} = \frac{\pi D^2 S_{max}}{G d Y} \tag{17}$$

A maximum stress of $S_{max} = 120{,}000$ psi will be assumed here. For spring index $C = 8$, Equation

Nomenclature

B = Free length of spring
$C = D/d$ = Spring index
D = Mean diameter of spring, in.
d = Wire diameter, in.
F = Total spring deflection, in.
f = Deflection per coil, in.
G = Torsional modulus of elasticity, psi
$K = 2d$ = Length correction for springs with closed or squared ends, in.
L = Free coil length or pitch, in.
N = Number of active coils
P = Applied load, lb
S = Torsional stress, psi
Y = Stress correction factor (Wahl)

17 becomes

$$f_{max} = 1.776\,d \tag{18}$$

and

$$L = f_{max} + d = 2.776\,d \tag{19}$$

By definition,

$$N = \frac{F}{f} \tag{20}$$

Combining Equations 16 and 20 and rearranging terms,

$$\frac{F}{B-K} = \frac{f}{L} \tag{21}$$

From the fundamental spring relationship, Equation 1, substituting for f (Equation 21) and then for L (Equation 19),

$$\frac{F}{B-K} = \frac{\pi D^2 S}{2.776\,Gd^2 Y} \tag{22}$$

Since $C = D/d = 8$ is assumed for this analysis, Equation 22 becomes

$$\frac{F}{B-K} = \frac{64\pi S}{2.776\,GY} = kS \tag{23}$$

where k is a constant for a given spring index and material. For music wire, $G = 11{,}500{,}000$ psi, and for $C = 8$, $Y = 1.18$ (Fig. 4 of previous article). Substituting in Equation 23 and solving for S,

$$S = \frac{F}{5.34(10^{-6})(B-K)} \tag{24}$$

This equation is the equivalent of Equation 12 for extension springs.

Chart Development and Application: Based on the same techniques of graphical analysis used for extension springs, Design Charts 5, 6, 7, and 8 have been developed for design of compression springs with standard indexes of $C = 6$, 8, 10, and 12, respectively. Arrangement of scales, Stress Line and wire curves on these charts follows the same general form used in the previous charts. The only significant change is the scale for active spring length, $B - K$, which replaces the former scale for body length.

In the use of these charts, the same general procedure as for extension springs is followed (Design Chart 6 for $C = 8$ is preferred for problem solutions):

1. Assume values for active length $B - K$ and total deflection F.

2. On Design Chart 6 ($C = 8$), draw a line between the F and $B - K$ scales, connecting the values assumed in Step 1. Intersection of this line with the Stress Line gives the resulting stress, S. If this stress is too high, try the corrective steps suggested for extension springs.

3. Draw a line parallel to the P scale through the intersection point found in Step 2. Where this line intersects the various wire curves, draw lines to intersect the P scale and read the load values corresponding to stress S (Step 2) for the different wire sizes. If these load values are not satisfactory, try the corrective steps suggested for extension springs.

In these charts, as in the others, no units of length have been specified on the F and $B - K$ scales. Any consistent set of units may be used and both scales can be multiplied by the same factor without altering the solution for stress S. These charts also can be employed with materials other than music wire by using the constants given in Table 2 of the previous article.

It should be remembered that compression springs increase in diameter when deflected. When a spring is to be mounted in a hole, it should not fit too tightly before being compressed.

Also, compression springs have a tendency to buckle under load. Amount of buckling to be expected on a specific spring design is given in Fig. 6. For any application where buckling is likely, the spring should be guided by assembly in a hole or over a rod.

Example Problem: Design a compression spring to return the punch in a paper-punch unit to its initial position after forming hole. The spring must operate over the outside of the punch. Design assumptions are:

1. Estimated force required for punch return, $P_2 = 4$ lb.
2. Minimum force required to support punch in up position, $P_1 = 1$ lb.
3. Punch stroke = 0.22 in.
4. Length of spring before punch starts stroke = 0.50 in.
5. Punch diameter, $D_p = 0.250$ in.

First step is to select a spring that will fit over the punch. From the table of coil dimensions on Design Chart 6, a wire diameter of $d = 0.041$ in. give O.D. = 0.369 in. and I.D. = $0.369 - 2(0.041) = 0.287$ in. which should satisfy assembly requirements.

Estimate active length as 0.56 in. If allowance for dead end coils is neglected initially, at start of stroke, total deflection $F_1 = 0.06$ in. At end of stroke, total deflection $F_2 = 0.22 + 0.06 = 0.28$ in.

On Design Chart 6, draw a line from $F_2 = 0.28$ to $B - K = 0.56$. Through the Stress Line intersection point, draw a line parallel to P scale. Where this line intersects the wire curves, draw lines to intersect P scale. For wire diameter $d = 0.041$ in., read $P_2 = 6.5$ lb (approximately) which exceeds the force requirement established in assumption 1. Based on the general form of size-force relationships, it appears that a spring of larger index is needed.

On Design Chart 7 ($C = 10$), following the same general procedure as before, $P_2 = 3.75$ lb for $d = 0.035$ in. (I.D. = 0.315 in.), which should be adequate for this application.

Since active length $B - K = 0.56$ in., a spring with squared ends will have free length $B = 0.56 + 2(0.035) = 0.63$ in. Initial deflection $F_1 = 0.63 - 0.50 = 0.13$ in. and final deflection $F_2 = 0.63 - 0.28 = 0.35$ in. As a check on final and initial loads, connect $F_2 = 0.35$ in. with $B - K = 0.56$ in. on Design Chart 7. Find load $P_2 = 4.25$ lb. Now connect $F_1 = 0.13$ with $B - K = 0.56$ in. Read $P_1 = 1.5$ lb. Thus, this spring satisfies all of the original assumptions.

DESIGN CHART 5 — Compression Springs

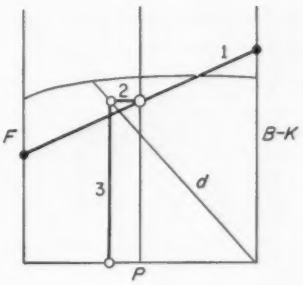
$C = D/d = 6$

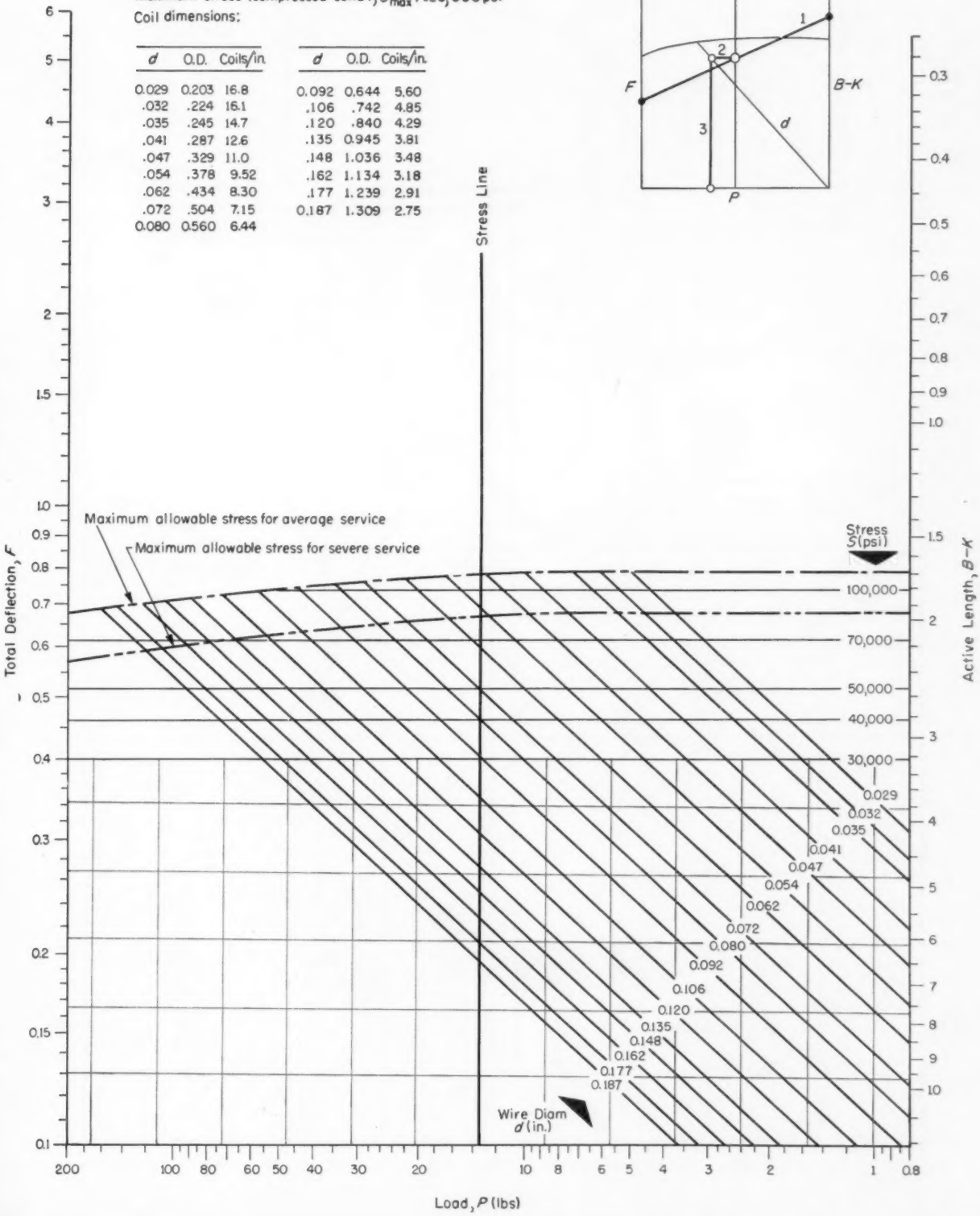
Material: Music wire

Maximum stress (compressed solid), S_{max}: 120,000 psi

Coil dimensions:

d	O.D.	Coils/in.	d	O.D.	Coils/in.
0.029	0.203	16.8	0.092	0.644	5.60
.032	.224	16.1	.106	.742	4.85
.035	.245	14.7	.120	.840	4.29
.041	.287	12.6	.135	0.945	3.81
.047	.329	11.0	.148	1.036	3.48
.054	.378	9.52	.162	1.134	3.18
.062	.434	8.30	.177	1.239	2.91
.072	.504	7.15	0.187	1.309	2.75
0.080	0.560	6.44			





DESIGN CHART 6 – Compression Springs

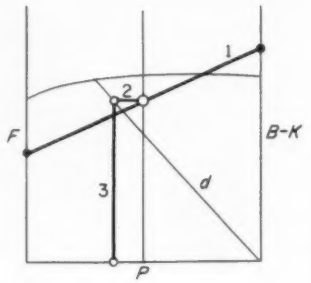
$C = D/d = 8$

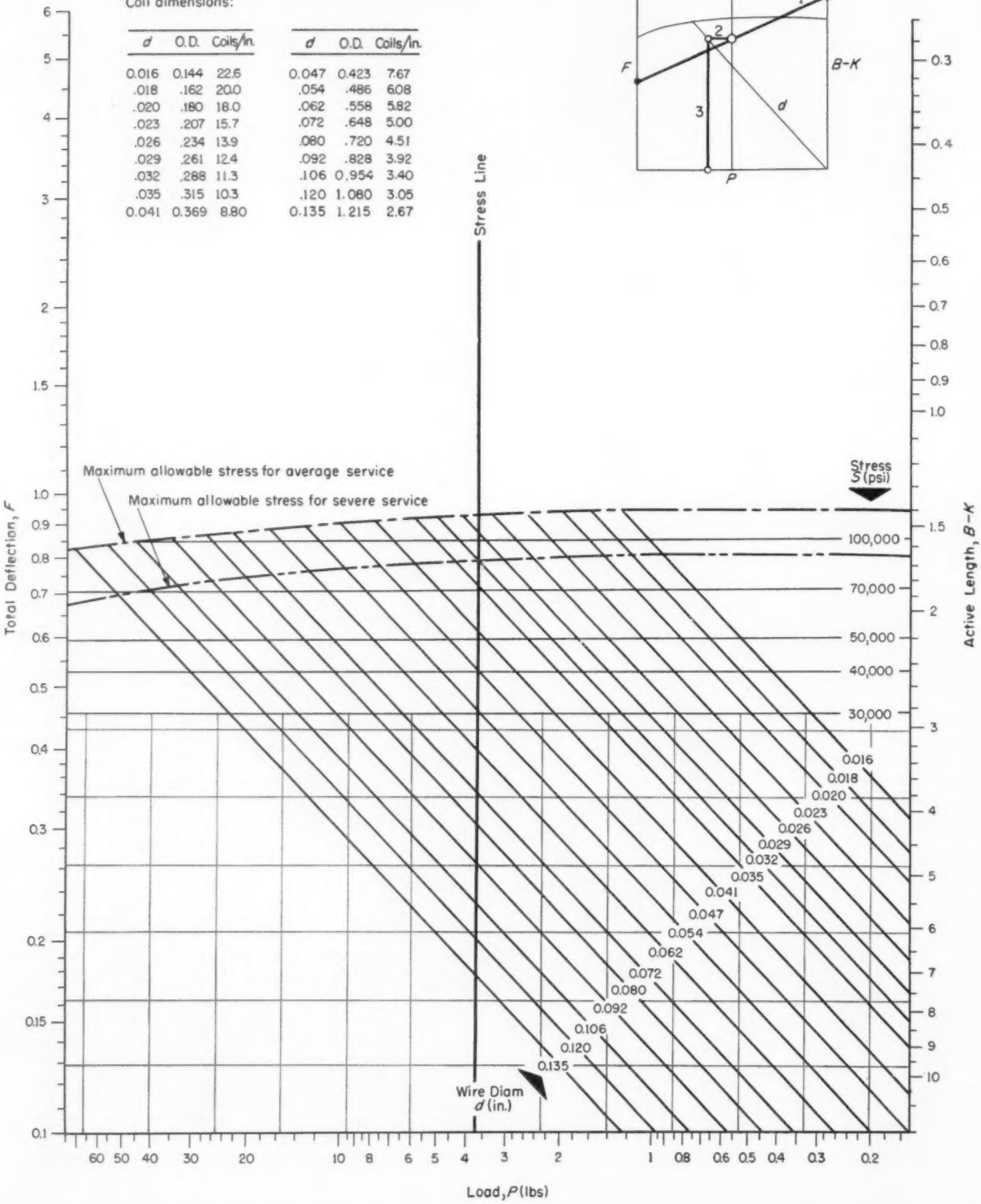
Material: Music wire

Maximum stress (compressed solid), S_{max}: 120,000 psi

Coil dimensions:

d	O.D.	Coils/in.	d	O.D.	Coils/in.
0.016	0.144	22.6	0.047	0.423	7.67
.018	.162	20.0	.054	.486	6.08
.020	.180	18.0	.062	.558	5.82
.023	.207	15.7	.072	.648	5.00
.026	.234	13.9	.080	.720	4.51
.029	.261	12.4	.092	.828	3.92
.032	.288	11.3	.106	0.954	3.40
.035	.315	10.3	.120	1.080	3.05
0.041	0.369	8.80	0.135	1.215	2.67





DESIGN CHART 7 — Compression Springs

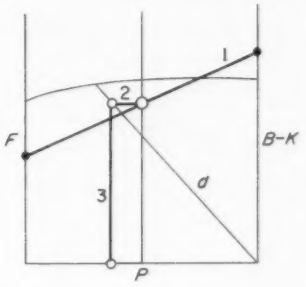
$C = D/d = 10$

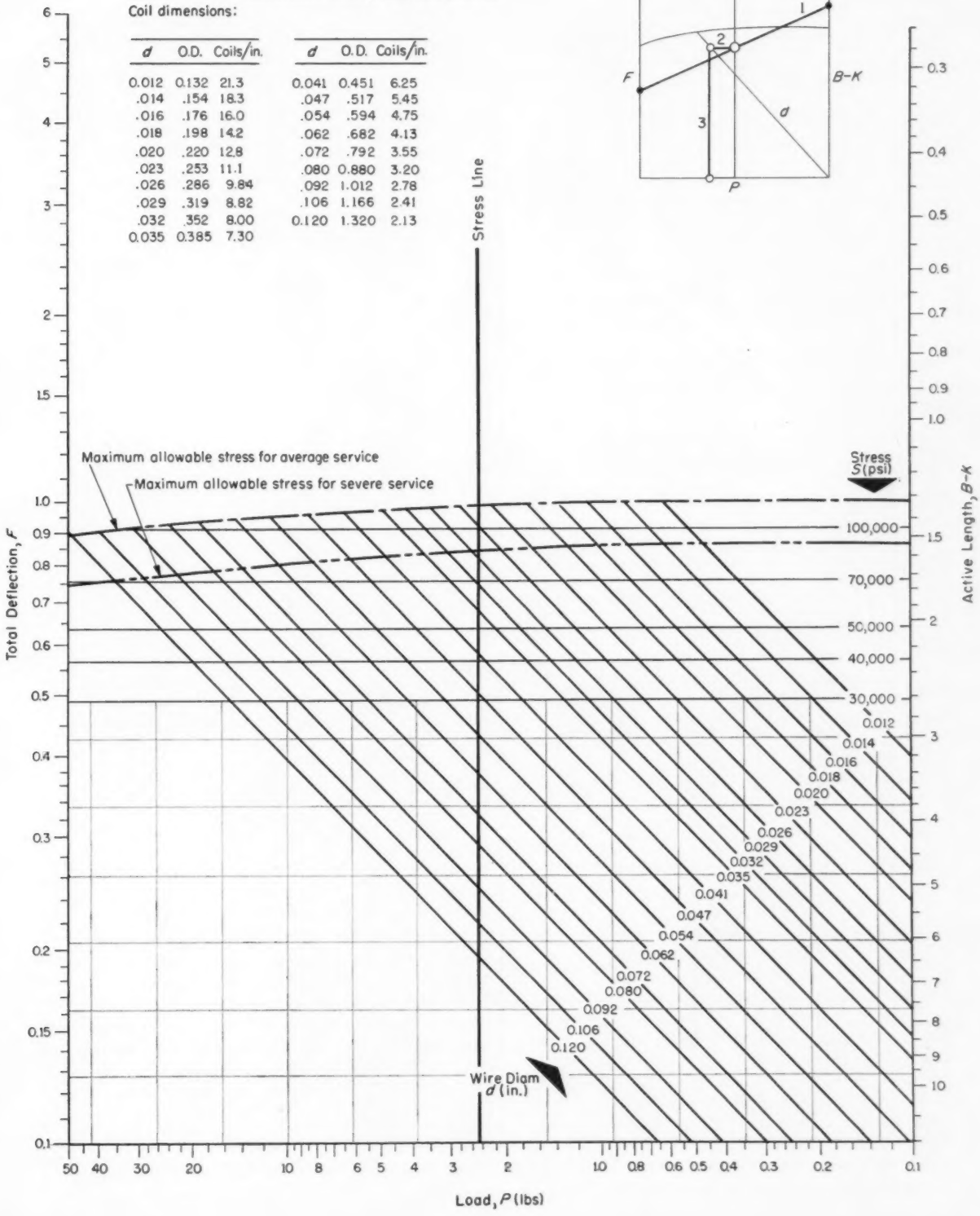
Material: Music wire

Maximum stress (compressed solid), S_{max}: 120,000 psi

Coil dimensions:

d	O.D.	Coils/in.	d	O.D.	Coils/in.
0.012	0.132	21.3	0.041	0.451	6.25
.014	.154	18.3	.047	.517	5.45
.016	.176	16.0	.054	.594	4.75
.018	.198	14.2	.062	.682	4.13
.020	.220	12.8	.072	.792	3.55
.023	.253	11.1	.080	0.880	3.20
.026	.286	9.84	.092	1.012	2.78
.029	.319	8.82	.106	1.166	2.41
.032	.352	8.00	0.120	1.320	2.13
0.035	0.385	7.30			





DESIGN CHART 8 – Compression Springs

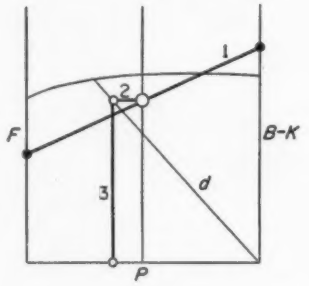
$C = D/d = 12$

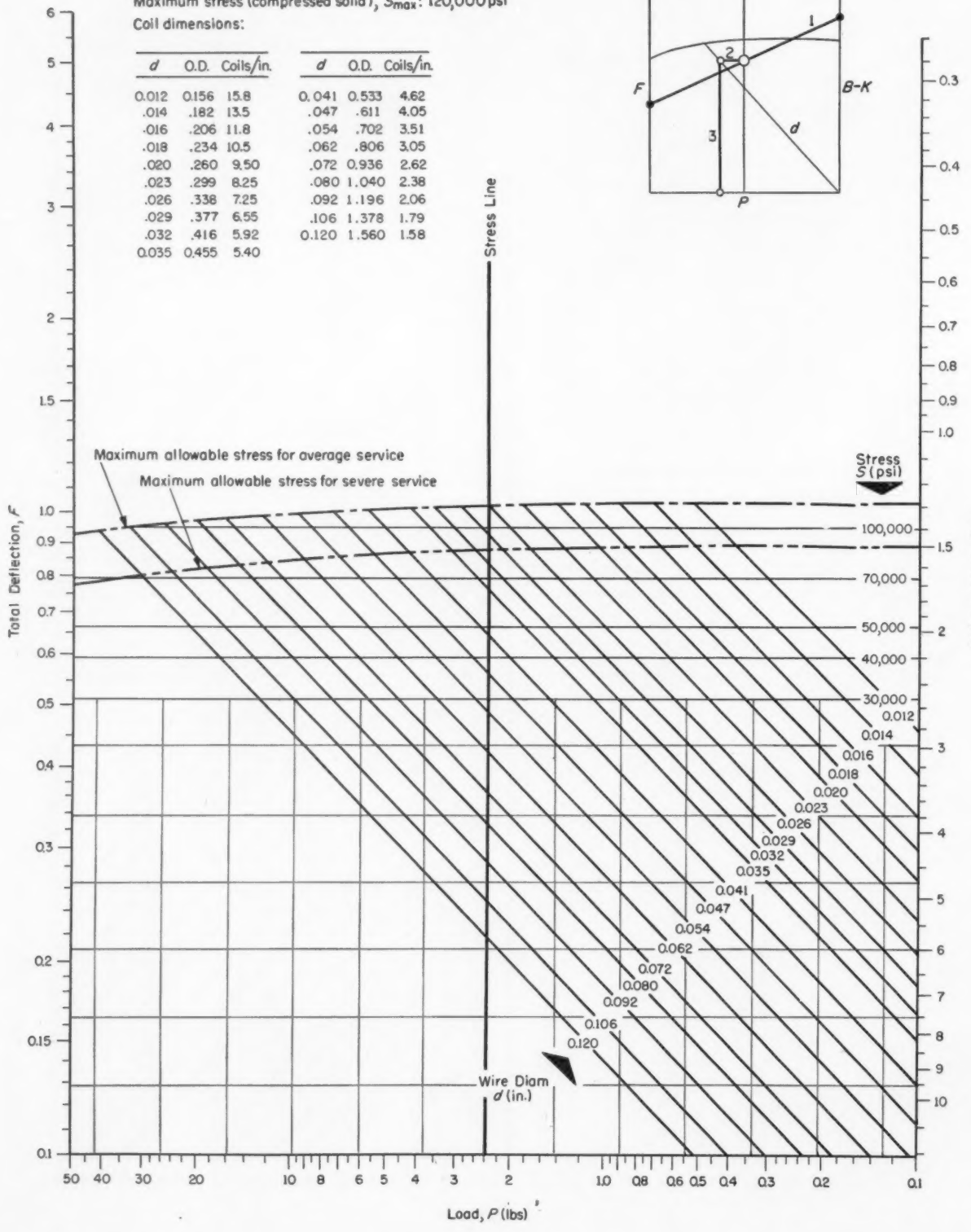
Material: Music wire

Maximum stress (compressed solid), S_{max}: 120,000 psi

Coil dimensions:

d	O.D.	Coils/in.	d	O.D.	Coils/in.
0.012	0.156	15.8	0.041	0.533	4.62
.014	.182	13.5	.047	.611	4.05
.016	.206	11.8	.054	.702	3.51
.018	.234	10.5	.062	.806	3.05
.020	.260	9.50	.072	0.936	2.62
.023	.299	8.25	.080	1.040	2.38
.026	.338	7.25	.092	1.196	2.06
.029	.377	6.55	.106	1.378	1.79
.032	.416	5.92	0.120	1.560	1.58
0.035	0.455	5.40			





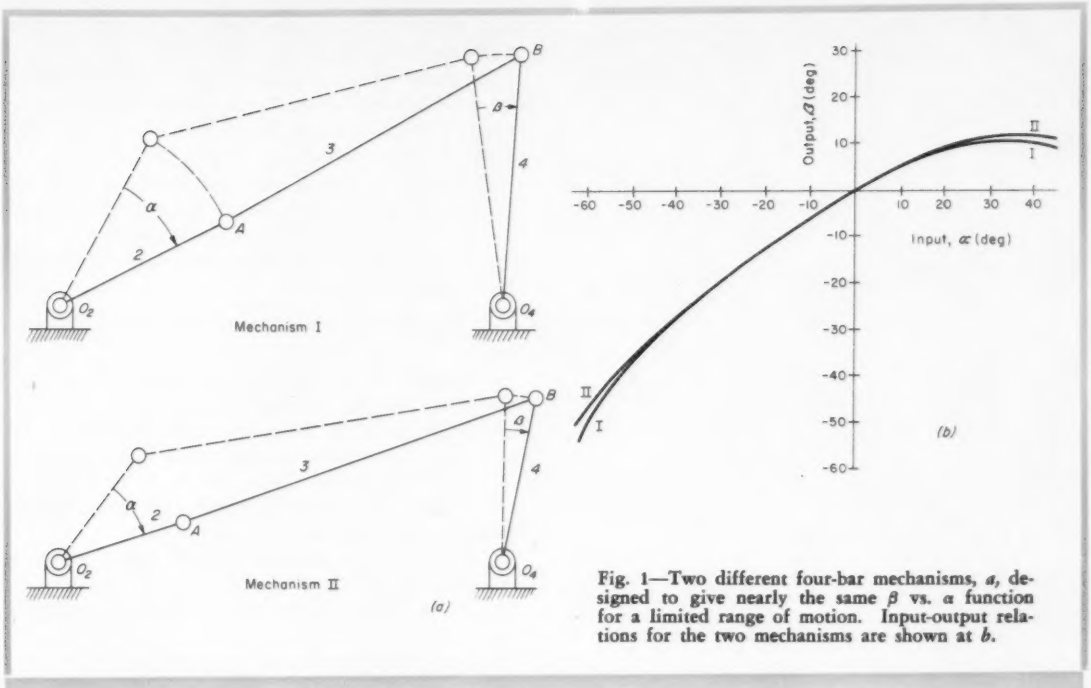


Fig. 1—Two different four-bar mechanisms, *a*, designed to give nearly the same β vs. α function for a limited range of motion. Input-output relations for the two mechanisms are shown at *b*.

Alternate Four-Bar Mechanisms

. . . a method for finding a number of designs that provide the same crank-motion relationship over a small motion range

By ALLEN S. HALL JR.
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THE four-bar mechanism is widely used for transforming oscillatory motion. Design problems are quite varied but can be grouped loosely into a small number of categories. In one category are those applications in which a certain relation between the two crank motions must be maintained quite accurately, but only for a small range of motion. For any one design problem, usually no one "best" design can be determined. However, a number of designs producing nearly identical relationships between the crank displacements within the range of interest can be found. From among these the designer may then choose on the basis of practical considerations other than the bare motion specifications.

Fig. 1 shows, as an example, two different four-bar mechanisms, plus the output-input displacement relation for each. Notice that, despite the large difference in relative link lengths in the two mechanisms, the two displacement curves are practically indistinguishable from each other over a range of input motion of approximately 60 degrees. Another way of demonstrating the agreement between the two curves is shown in Fig. 2 where the output displacements of the two mechanisms (for the same α) have been plotted against

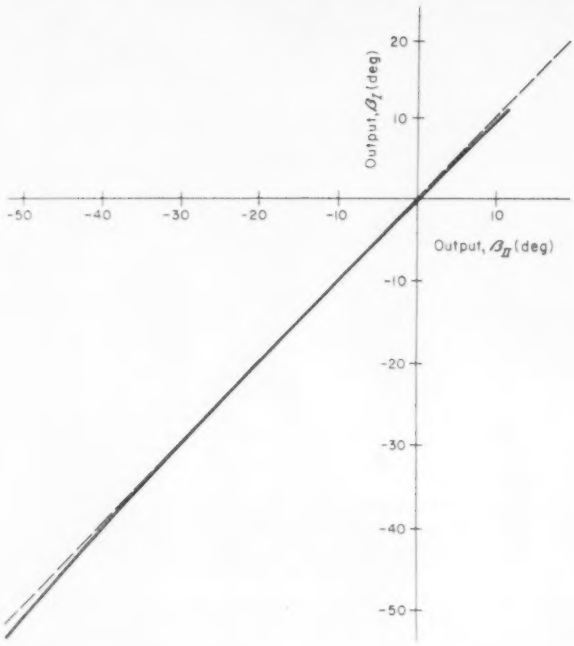


Fig. 2—Outputs, β, for the two mechanisms of Fig. 1 plotted against each other. Error in agreement between the two outputs is shown by deviation from 45-deg line.

each other. If the agreement were perfect, this plot would yield a 45-deg line.

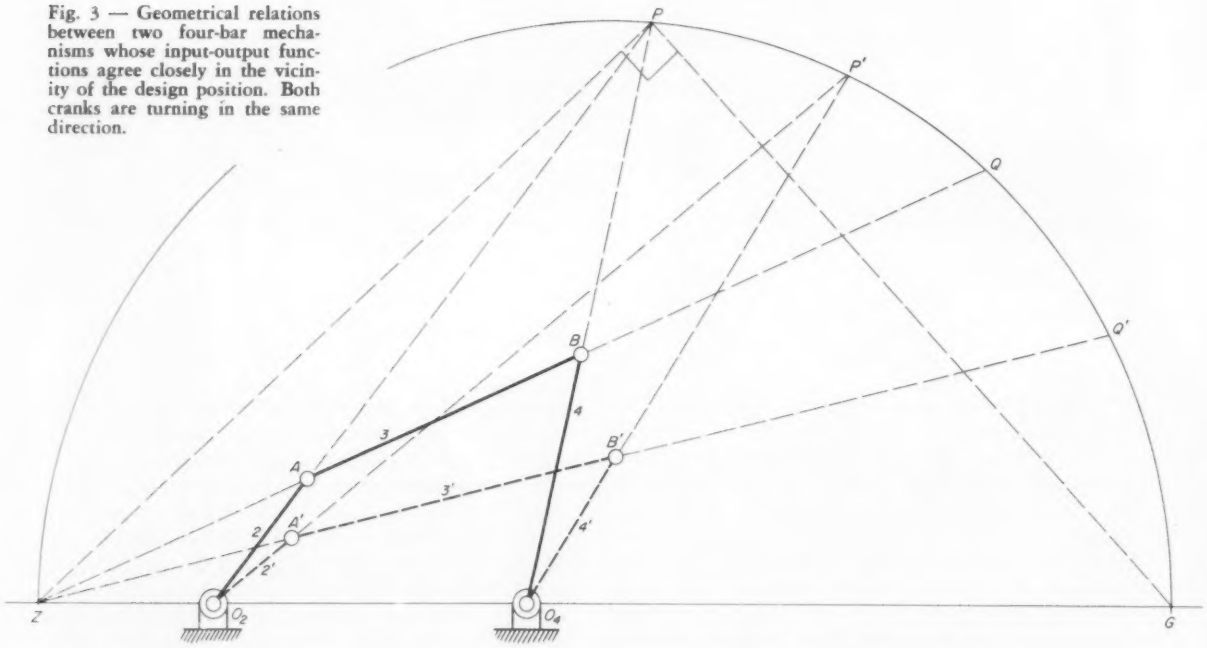
The geometrical relations between any two four-bar mechanisms, whose input-output curves are related to each other as demonstrated in the foregoing example, are shown in Fig. 3 and 4.

Referring to Fig. 3, assume that the four-bar mechanism shown with solid lines is given, and that another whose input-output function will be very nearly the same is to be found. The procedure is as follows:

1. Extend the two crank lines to their intersection at P.
2. Extend the connecting-rod line, AB, until it intersects the line through the pivots, O_2O_4, at Z.
3. Draw line ZP. Construct the normal to ZP at P, extending it until it intersects line O_2O_4 at G.
4. Draw the circle having ZG as a diameter.
5. Extend the connecting-rod line AB until it intersects the circle at Q.
6. On the circle select a point P' and draw lines from P' to O_2 and O_4.
7. On the circle locate point Q' such that $Q'Q = P'P$.
8. From Q' draw a line to point Z.
9. Points A' and B', determined by the intersection of line $Q'Z$ with $P'O_2$ and $P'O_4$, respectively, are crankpins for the new four-bar mechanism, shown with broken lines.

If, for the original four-bar (O_2ABO_4), we were to plot the displacement of link 4 versus position

Fig. 3 — Geometrical relations between two four-bar mechanisms whose input-output functions agree closely in the vicinity of the design position. Both cranks are turning in the same direction.



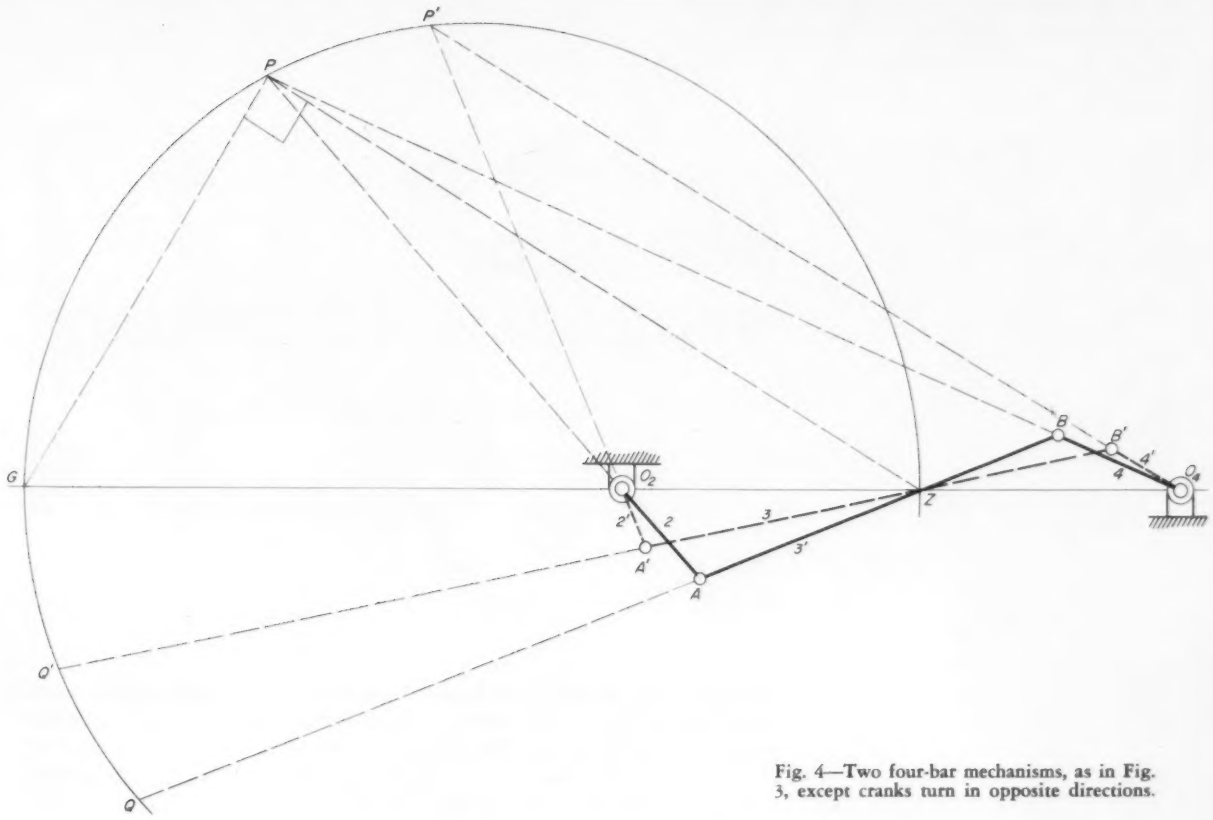


Fig. 4—Two four-bar mechanisms, as in Fig. 3, except cranks turn in opposite directions.

of link 2, starting from the position shown, and then do the same for the new four-bar, we should find that the two curves coincide quite closely for an appreciable range of motion. More specifically, the two curves will have the same slope, curvature, and rate of change of curvature at the origin. This fact does not guarantee that they will coincide within any specified tolerance over any specified range of motion, but it does insure that in the vicinity of the design position the two mechanisms will behave very much alike.

The example of Fig. 3 is for the case in which the two cranks turn in the same direction. For the crossed four-bar the procedure is the same but the appearance of the finished layout will be somewhat different, as shown in Fig. 4.

REFERENCE

1. W. J. Carter—"Kinematic Analysis and Synthesis Using Collineation-Axis Equation," *Trans.* ASME, August, 1957, Discussion by A. S. Hall Jr., pp. 1305-1312.

A Mechanisms Conference Paper

This article was presented as a paper at the Fourth Conference on Mechanisms, Purdue University, October 14-15, 1957. These Conferences are cosponsored by the Purdue School of Mechanical Engineering and *Machine Design*.

Tips and Techniques

Improving French Curve

Roughening one side of a French curve with emery cloth greatly improves its usefulness. The roughened surface will accept pencil marks to indicate termination points of the proper curved edge when making duplicate or symmetrical lines (turn the curve over for symmetrical lines). Pencil notations of tangent lines, center lines, and other reference points can also be made.—FRED BEEKMANN, *Kennsington, Md.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

How metallurgical factors influence

DESIGN OF HYDRAULIC EQUIPMENT

for high-temperature applications

By A. MARS and **N. M. LAZAR**

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Wayne State University
Detroit, Mich.

Selection of metals for high-temperature hydraulic equipment is governed by certain metallurgical factors inherent in available materials. Here is an evaluation of these factors in relation to their influence on equipment design, and a discussion of metals which appear to meet the requirements of high-temperature applications in the 400 to 900 F temperature range

HYDRAULIC equipment for high-temperature applications must be designed for high unit stresses, both static and dynamic, because of weight and space limitations. Additional severe requirements are imposed because sliding parts necessitate consideration of wear properties. Since wear resistance generally is a function of hardness, metals used for many parts must be able to retain high-hardness values at elevated operating temperatures.

Metallurgical Considerations

Selection of metals for hydraulic applications must be based on one or more of the following properties: Short-time high-temperature strength, creep rupture, creep strength, fatigue strength, stress relaxation, thermal - stress fatigue, thermal expansion, and wear resistance. All of these properties depend to some extent on the structural stability of the alloy at the temperature to which the equipment is exposed.

Creep Properties: In a general way, behavior of metals can be compared on the basis of the homologous temperature scale. On this scale, the range between absolute zero and the melting points of metals is divided into equal parts. Absolute zero is the zero point and the melting point is 1 for each metal. At similar homologous temperatures the metals behave approximately in a similar manner. A metal, loaded below its yield strength, deforms below 0.35 to 0.40 homologous temperature. No further deformation occurs regardless of duration. Above this range, creep occurs under similar loading conditions. Variations in microstructure cause modifications in this behavior. High-temperature properties are influenced by many factors such as composition, method of manufacture, heat-treatment, and deformation history.

Different applications and types of loading require different microstructures. For example, it was found that in a low-alloy chrome-molybdenum steel, a fine bainite structure is better than martensite

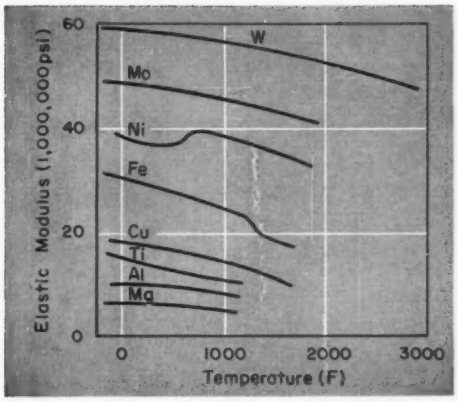

Fig. 1—Effect of temperature on elastic modulus of various materials

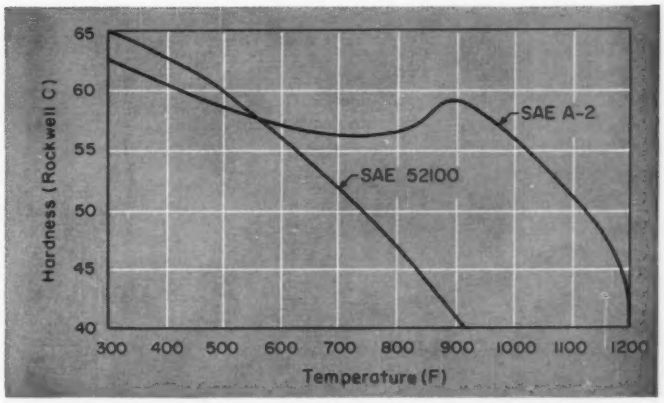

Fig. 2—Effect of tempering on hardness of SAE 52100 and SAE A-2 tool steels

for short-time tensile and stress rupture while coarse bainite is best for creep strength at 900 to 1000 F. For impact and high ductility, tempered martensite is more desirable. It was also observed that banding (segregated structure of parallel bands in the direction of working) decreases creep strength of low-alloy steels.

Structural stability at operating temperatures results in improved creep properties. Any structural change, taking place simultaneously with creep, increases creep rate. Stress raisers, even at elevated temperatures, appear to decrease creep-rupture properties. Indications are that this may be due to an increase in notch sensitivity caused by aging.

Cyclic Loading: There is evidence which indicates that the aging process in low-carbon steel is accelerated by cyclic stresses, i.e., structural stability is decreased. The lives of turbine blades were considerably less than predicted from stress-rupture data when cyclic loads were superimposed on mean stresses. However, for some high-temperature alloys in the temperature range of 1200 to 1650 F, superimposition of cyclic stress on mean stress caused a variety of creep-rupture behavior which ranged from accelerated rupture to delayed creep and rupture. This depends on mean load and amplitude, or the cycle of the superimposed load and the ratio of superimposed load to mean load.

High-Temperature Fatigue Properties: There is evidence that some heat-resistant alloys have superior high-temperature fatigue strength, at least in some temperature ranges, in the fine-grain condition. Thermal cycling causes a decrease in creep life similar to that caused by cyclic loading. The mode of initiations of cracks during thermal cycling is different than in mechanical fatigue. As a result of differential thermal expansion, thermal stresses can exceed yield strength and cause plastic deformation. The problem must be considered in terms of strain rather than stress.

Elastic modulus decreases with increasing temperatures. Relation of elastic modulus to temperature for various metals is shown in Fig. 1. This decrease affects size, fit, and wear of equipment designed for high-temperature use.

Effect of Environment: For a number of high-temperature alloys, rupture life is longer in an oxidizing atmosphere than in an inert atmosphere. This indicates that high-temperature environment may play an important role in the life of hydraulic equipment and that it should not be overlooked.

Wear Resistance at High Temperatures: While there are other metallurgical factors to be considered, wear generally correlates well with hardness. Hence, wear resistance at elevated temperatures may be evaluated on the basis of resistance to softening. For steels, this may be done by comparing their tempering curves. Fig. 2 shows the tempering curve of SAE 52100 and SAE A-2 tool steels. It is apparent that a steel having a secondary hardness range is more resistant to tempering and should perform better in high-temperature wear applications. Although this approach does not take into consideration fatigue and creep effects, it is the beginning of the solution to the problem of wear in high-temperature hydraulic equipment. The temperature involved is below the temperature at which maximum secondary hardness of the SAE A-2 tool steel is developed. It is estimated that the temperature at which creep would be significant in these steels also would be above the secondary hardening temperature.

Another index for wear resistance at high temperature is hot-hardness values. These, however, are still to be correlated with performance.

Materials For High-Temperature Hydraulic Equipment

Tool steels having a secondary hardness range on tempering at 800

to 1100 F show promise for highly stressed components and for wear-resistant applications in hydraulic equipment for use to about 800 F. SAE H-12, hot-work die steel, when tempered at 1000 F, has a tensile strength of 180,000 psi and a yield strength of 140,000 psi. It is estimated that after tempering at 1090 F this alloy has structural stability for 100 hr at a temperature of 1000 F.

Evaluation of hot-work die steels for high-temperature application showed that these steels have good structural stability and creep-rupture properties to 900 and 1100 F. Comparison of SAE 422 and PH 15-7 Mo stainless steels with hot-work die steels (with respect to elevated-temperature tensile strength and short-time stress-rupture properties) showed that the die steels are superior to 1200 F and have the highest strength-to-weight ratio to 1200 F of any commercial structural metals.

Yield-strength-to-weight ratios are shown in Fig. 3 for various high-temperature alloys. It is apparent that tool steels with high tempering temperatures show promise for structural and wear-resistant applications involving a temperature requirement between 800 and 1000 F. Another group of steels which may be considered for this range of temperatures is the precipitation-hardening stainless steels.

Cast Irons: Gray, malleable, and nodular irons appear to be usable to 1000 F. The pearlitic matrix is superior to ferritic below 800 F. Above 800 F, stability of pearlite decreases and loses its advantage over ferritic irons. The austenitic irons should be useful to 1200 or 1300 F.

Titanium-Base Alloys: Unnotched fatigue properties of titanium-base alloys were investigated in a temperature range of 200 to 1000 F. Results indicate that these alloys are useful for structural application in this temperature range. Additional work is required to improve titanium in wear applications to at least 700 F.

Aluminum and Magnesium-Base Alloys: Creep properties of commercially available aluminum and magnesium alloys decrease above 350 F. New experimental alloys have been reported recently which, when commercially available, may extend the usefulness of these alloys to the 600 to 700 F range.

Service Performance

Performance experience to date has been mainly with tool steels in applications where it was necessary to replace carburized parts and SAE 52100 steel. Results were also obtained of tests of various cast irons in applications to 500 F fluid temperature.

Tool Steels: Parts made from SAE 52100 and carburized steels lose their usefulness in many sliding-wear applications at operating temperatures around 350 F. SAE-A2 type tool steels were tested to replace these materials in high-temperature applications. This steel was selected for a preliminary investigation because of its resistance to tempering and because of its relatively low cost. Improvement in high-temperature performance resulted. Improved wear resistance of this steel may be attributed to its resistance to softening. In addition, production economies have resulted in some cases because this steel is air-hardening and requires only a simple heat-treating process.

High-speed tool steels of the SAE M-2 type show good resistance to wear in a fluid temperature to 500 F. It is expected that this steel will be useful to higher temperatures. The more recently developed, lower cost SAE M-52 steel with a total lower alloy content can be used in many applications.

Test results on a vane pump revealed that hot hardness, red hardness, and original room-temperature hardness are important factors in wear-resistant characteristics at room temperature or at elevated temperatures. The tests also showed need for structural stability by means of alloying elements. The minimum of total alloying elements that must be present to maintain a required wear-resistant level depends largely on applications. In bearing applications, SAE M-52 has the minimum alloying content required as a bearing material in applications over 300 F and possibly in excess of 500 F.

The short-time hot hardness of high-speed tool steels is retained in a fairly narrow hardness band to

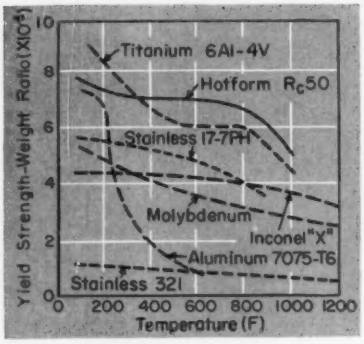

Fig. 3—Strength-to-weight ratios of various engineering alloys

1000 F. Generally speaking, the higher alloyed grades exhibit superior hot-hardness properties. Above 1000 F hot hardness falls off rapidly. Indications are that hot hardness is maintained at a constant level to 500 hr of exposure at this temperature.

Hardness in the low-alloy type steels, such as 52100, 8620 carburized, etc., falls off rapidly for temperatures above 400 F. These steels must therefore be tempered above operating temperatures which necessarily results in lower room-temperature properties. Such treatment might be satisfactory for equipment where load, temperature, and other conditions are not too severe.

Stainless steels have been used in high-temperature applications where corrosion or oxidation resistance is required. Since the application involves wear, type 440-C will meet the high-hardness requirement.

The 17-4 and 17-7 PH steels maintain good strength levels up to their aging temperatures. This material is especially useful when distortion must be minimized since only aging is required after machining.

Cast Irons: Cast irons promise substantial cost reduction as a material for pistons, vanes, and valve plates. Chilled cast-iron vanes were tested to replace tool-steel vanes in a standard vane-type hydraulic pump. Test results after 100 hr revealed that the chilled iron with 0.50 per cent each of chrome, molybdenum, and nickel were comparable to tool steel. The carbides formed withstand temperatures to 1400 or 1500 F without decomposition. The two-phase structure follows the general rule for good wear.

Based on results of the vane-pump test, the chilled material was also

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Grinding the flange on a HYATT outer race.

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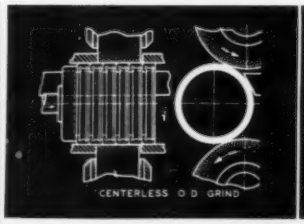
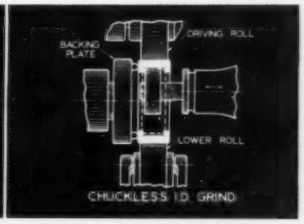
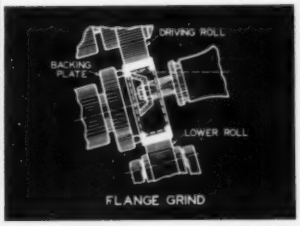
You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Pittsburgh, Detroit, Chicago, and Oakland, California.



Through-feed centerless grinding provides an O.D. with minimum out-of-round and helps reduce costs.

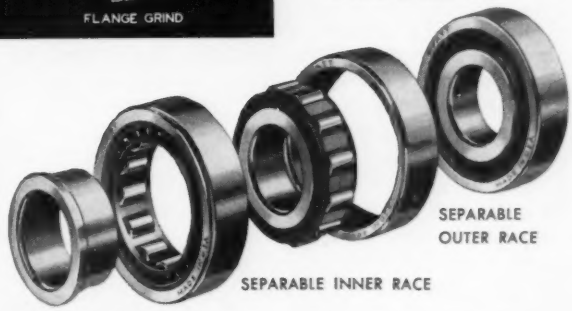


Next, race is driven on O.D. and ground centerless to generate an I.D. cylinder concentric with O.D.



Flanges are ground using race ends as reference. Result is race of as nearly perfect geometry as practical.

NON-SEPARABLE TYPE



THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

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HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

tried as a wear plate at 500 F. Tests on the wear plate revealed excellent results. Good resistance to scoring and galling was demonstrated even under adverse operating conditions. In addition to excellent wear resistance at temperatures to 500 F, the chilled material was found useful for less severe applications to replace more costly material.

Another example which might be cited is the successful substitution of nodular and malleable iron in the quenched and tempered condition for carburized alloy steel in a 500 F application. During this development work, other favorable properties of these materials seemed apparent. These properties made it possible to reduce wear and end play, and to lower the friction load. In addition, these irons replaced a material which was structurally unstable at the same temperatures. Both types of cast irons are now used on mating parts, permitting operation over a wider temperature range with a reduction of problems due to differential thermal expansion.

When thoroughly hardened and tempered, cast-iron components have a service life more than four times as great as that of steel parts running under the same conditions. Strength and wear characteristics of the irons are determined by the carbon equivalent, the graphite distribution, and the matrix structure.

Chromium, as an alloying element, is a strong carbide former and retards growth of the part during subsequent heat applications because of the stabilizing effect on the matrix structure. In addition to stabilizing carbides, molybdenum also improves creep resistance of the cast irons.

Titanium-Base Alloys: Inherent galling tendencies of titanium-alloys were eliminated by plating with electroless nickel plating. While wear resistance was greatly improved, difficulties were encountered in obtaining a uniform adhesion of nickel plate. Surface oxides are believed to be a cause of occasional poor adhesion. Residual surface stresses as a result of machining might also be a contributing factor. X-ray diffraction methods were used in an attempt to correlate residual stresses with poor adhesion but nothing conclusive was established. Nitrided titanium samples have good antigalling properties under light loads, although impact properties are very adversely affected by nitriding.

From a paper entitled "Metallurgical Factors in the Design of Hydraulic Equipment for Elevated Temperature Application," presented at the ASME-ARS Joint Aviation Conference in Dallas, Tex., March, 1958.

New High-Strength Molding Materials

For Applications to 5000 F

By S. G. SALZINGER and H. M. TOELLNER, Coast Manufacturing and Supply Co., Livermore, Calif.

A NEW series of glass-fiber reinforced plastic molding compounds has been developed which combines high temperature resistance with maximum strength. These premix molding materials consist of glass yarns coated with any one of a number of specially designed resin systems. Glass content is high, to 70 per cent by weight, and available resin systems include phenolics, silicones, polyesters, and epoxies. The characteristic high strength at temperature is due to the glass-fiber content which is more than twice that of presently available molding compounds.

Molded parts of any shape, and with thick or thin cross sections, can be made easily in both compression and transfer molds. Successful applications of these new compounds include cover assemblies and gaskets for electrical components, missile stabilizers, rocket nozzle sections, threaded bolts, junction boxes with metallic inserts, and cutting-wheel bases.

Available compounds include those which retain maximum mechanical properties at 500 to 1000 F, show excellent resistance to temperatures as high as 5000 F (or higher for short durations), have good insulation properties, and exhibit excellent corrosion resistance. Others of the compounds combine excellent mechanical, electrical, and chemical properties.

Specific advantages of these molding compounds are:

1. The high glass content results in a very high strength-to-weight ratio.
2. Both the glass yarn and resin system are designed for specific applications.
3. Compounds are available in a large variety of resin systems some of which are not normally available in molding material form.
4. High-flow characteristics of the compounds at reasonable molding pressures result in excellent distribution of resin and glass.

These molding compounds may fill the gap between present low-strength molding materials and high-strength laminating materials. Many parts can be molded at high production rates and relatively low cost. Also, many parts previously considered impractical can now be produced from reinforced plastic.

From a paper entitled "A New High Strength Molding Material," presented at the 13th Annual Meeting of the Reinforced Plastics Division of The Society of the Plastics Industry Inc. in Chicago, Ill., February, 1958.

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Circle 465 on Page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card — page 19

Drafting Room Equipment

Sizes, dimensions, and other specifications are tabulated for each piece of drafting room, art, and school equipment covered in Catalog GC-57. It lists flat files, mobile storage units, wood and steel drafting units, drawing and tracing tables, and accessories. 24 pages. Stacor Equipment Co., 295 Emmet St., Newark 5, N. J. D

Circle 541 on Page 19

Rubber Cup Packings

Folder on fabricated Vix-Syn rubber cup packings provides application notes and a table of maximum clearances between packing follower plates and cylinder walls, plus a listing of standard cup sizes. Bolted to end of piston or plunger, packings seal in 0 to 250° F range. 4 pages. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. C

Circle 542 on Page 19

Air & Hydraulic Cylinders

Bulletins H-101 and A-101 respectively describe 2000-psi H line hydraulic cylinders and 150-psi A line air cylinders. Both forms provide tabulated dimensional and force data and describe mounting styles. 8 pages each. Teer, Wickwire & Co., Lindberg Air & Hydraulic Div., Jackson, Mich. H

Circle 543 on Page 19

Mechanical Force Gages

Model X mechanical force gages described in Bulletin 11E are offered in 12 capacities from 0-10 to 0-50,000 lb. Gages are pictured in use alone or incorporated into special testing devices for measurement of pressure, tensile strength, or torque. 6 pages. W. C. Dillon & Co., 14620 Keswick St., Van Nuys, Calif. L

Circle 544 on Page 19

Torque Wrenches

Second edition of the "Torque Manual" descriptively covers torquing principles and operation involving company torque wrenches. Attachments and adapters are pictured, formulas and computations are given, and bolt tension and torque values are tabulated. Price is $1.50. 28 pages. P. A. Sturtevant Co., Addison, Ill. I

Circle 545 on Page 19

Hydraulic Presses

Range of hydraulic presses for laminating, pressing, die hobbing, preforming, and powder compacting is described in Bulletin 3300. It is complete with conversion tables, decimal equivalents, hydraulic ram capacities, wire and sheet metal gages, steel pipe tables, bolt tables, and other data. 40 pages. Baldwin-Lima-Hamilton Corp., Hamilton Div., Hamilton, Ohio. G

Circle 546 on Page 19

Bronze

Sabeco bronze, how it can be used, and the grades in which it is available are considered in brochure. Sabeco bronze is made from copper, tin, and lead, with only 2/10 of 1 per cent total impurities. 12 pages. Saginaw Bearing Co., 867 S. Water St., Saginaw, Mich. H

Circle 547 on Page 19

Relay Terms

Almost 200 definitions of relay terms suggested by National Association of Relay Manufacturers are contained in booklet, along with 21 diagrams illustrating contact arrangements and voltage and current parameters. 16 pages. Potter & Brumfield, Inc., Princeton, Ind. J

Circle 548 on Page 19

Electrical Binding Posts

Bulletin BP958 illustrates five ways to connect gold-plated brass parts to the 5-way binding post. Posts can be mounted and locked in any panel from 1/16 to ¼ in. thick. 4 pages. Superior Electric Co., Bristol, Conn. B

Circle 549 on Page 19

Constant & Variable Pumps

Denison hydraulic pumps described in Bulletin P-4-A are available for either constant or variable volume requirements. Pressure ratings range from 2500 to 5000 psi with deliveries from 2.1 to 34.9 gpm at 1200 rpm. 2 pages. American Brake Shoe Co., Denison Engineering Div., Columbus 16, Ohio. G

Circle 550 on Page 19

Worm & Gear Mountings

Through use of engineering drawings and tabulated specifications, Bulletin 750-C describes a complete line of standard mountings for double-enveloping worm-gear sets. Assemblies can be used in either standard Cone-Drive speed reducers, or custom-designed equipment. 20 pages. Michigan Tool Co., Cone-Drive Gears Div., 7171 E. McNichols Rd., Detroit 12, Mich. H

Circle 551 on Page 19

Pushbutton Guide

Line of pushbuttons, stations and units described in the Westinghouse Pushbutton Guide meets every conceivable control problem in any environment. Units are pictured with tabulations showing contact symbols, features, style number and list prices. Data cover general purpose, water and dust-tight, explosionproof, corrosion resistant, and special types. 80 pages. Westinghouse Electric Corp., Standard Control Div., Beaver Plant, Beaver, Pa. F

Circle 552 on Page 19

Numerical Positioning Control

"Application Data for Numerical Positioning Control" is title of Bulletin GET-2676 which describes functions of numerical positioning control; gives breakdown of data input, director, and servo drive elements; and provides data accumulated from applications on a variety of machines. 14 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 553 on Page 19

Valves

Gate, foot, swing check, cross check, angle check, vertical check, and cross valves are among the types descriptively covered in Bulletin F-24. Valves are used in handling of hazardous liquids, in food processing, and in corrosion resistant applications. 8 pages. Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio. G

Circle 554 on Page 19

Welding Electrodes

The "Weldirectory of Manual Electrodes" simplifies selection of the most efficient electrode for any welding job. Booklet gives physical properties, current ranges, sizes, and welding procedures for each available electrode. 12 pages. Lincoln Electric Co., Cleveland 17, Ohio. F

Circle 555 on Page 19

Heavy Duty Spindles

Heavy duty precision spindles for cylindrical and centerless grinding, boring, and milling are pictured in Bulletin S-11. Advantages are pointed up. 6 pages. Pope Machinery Corp., 261 River St., Haverhill, Mass. B

Circle 556 on Page 19

Subminiature Switch

Data sheet on the Model SM subminiature 10-amp switch describes characteristics, electrical life, and features and shows leaf, formed leaf, roller leaf, plunger, and toggle actuators. 2 pages. Robertshaw-Fulton Controls Co., Acro Div., Columbus 16, Ohio. G

Circle 557 on Page 19

Pneumatic Pilot Valves

Dimensions and specifications are given in folder on three-way pneumatic pilot valves offered with thread, base, or flange mountings. Valves require only 1/32 in.

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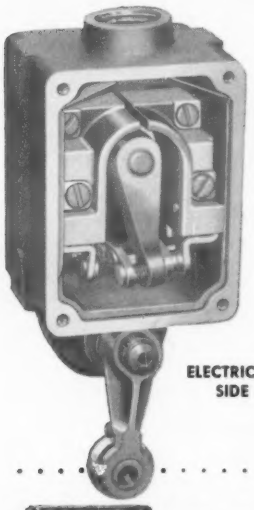
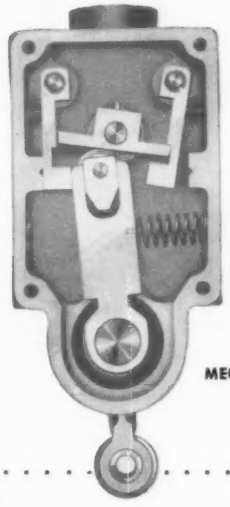
As illustrated below, National Acme SNAP-LOCK Limit Switches employ a basically simple yet positive *snap-action* locking mechanism—with extremely few moving parts. Thus wear is reduced to a minimum and dependable trouble-free service, far beyond normal limits, is assured.

The double-throw contact lever, connected directly by shaft with the latch bar, carries self-wiping coin silver contact points to assure quick action make or break—reducing wear ever further.

Electrical and mechanical sides are separated by a wall within a sturdy die-cast housing which is fully insulated and is dust and oil resistant. Can also be furnished water- and oil-tight.



ELECTRICAL SIDE



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SNAP-LOCK LIMIT SWITCHES. Made in single-pole and double-pole series, in four types: Standard, Short Travel, Neutral Position and Push Lever. With the exception of the Push Lever Switch, all are adaptable to special enclosures for hazardous location service and may be used with various styles of operating levers. For AC or DC service.

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Heavy duty silver-alloy contact points provide maximum electrical capacity, long life.
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travel and only 2.6-lb actuating force. 4 pages. Logansport Machine Co., Logansport, Ind. J

Circle 558 on Page 19

Stainless Steel

MicroRold 430 general utility stainless steel is subject of descriptive brochure which covers physical properties and analysis, corrosion resistance fabrication, application, maintenance, and cleaning. The straight chrome grade stainless has maximum carbon content of 0.12 per cent. 24 pages. Washington Steel Corp., Washington, Pa. G

Circle 559 on Page 19

U-Cup Packing

Uses, pressures, construction, available sizes and installation procedures relative to line of homogeneous U-cup packings are detailed in Bulletin AD-163. The molded synthetic rubber packings are used where instantaneous sealing is needed because of sudden pressure changes. 4 pages. Garlock Packing Co., 420 Main St., Palmyra, N. Y. F

Circle 560 on Page 19

Push-Pull Controls

Tru-Lay push-pull flexible controls for continuous or intermittent transmission of reciprocal motion are made in five sizes for light to heavy loads. Brochure covers applications, advantages, construction features, control dimensions, selection, and special heads. 16 pages. American Chain & Cable Co., Automotive & Aircraft Div., 601 Stephenson Bldg., Detroit 2, Mich. H

Circle 561 on Page 19

Retaining Rings

Engineering specifications on internal and external retaining rings are set forth in illustrated catalog. Details of stacked rings for production application or assembly are given. 16 pages. Industrial Retaining Ring Co., 57 Cordier St., Irvington 11, N. J. D

Circle 562 on Page 19

Research Facilities

Facilities of this company in the fields of industrial physics, and mechanical, electrical, chemical, and metallurgical engineering are explained in illustrated booklet entitled, "Polytechnic Research." Typical projects researched are cited, and resumes are given for principal personnel. 16 pages. Comstock & Wescott, Inc., 179 Fifth St., Cambridge, Mass. B

Circle 563 on Page 19

Zirconium & Hafnium

"Technical and Application Data on Zirconium and Hafnium" is title of brochure which discusses the properties of these metals and their nuclear reactor applications. Common mill shapes available are detailed. 16 pages. Mallory-Sharon Metals Corp., Niles, Ohio. G

Circle 564 on Page 19

Selenium Rectifiers

Physical characteristics, performance curves, and descriptions of various models of Grain-Oriented selenium rectifiers are included in Catalog No. EPD 3116-(1). They provide high current ratings without overloading. 48 pages. Vickers Inc., Electric Products Div., 1815 Locust St., St. Louis 3, Mo. I

Circle 565 on Page 19

High Temperature Valves

Several valves designed for nonproblematic control of radioactive material in the form of corrosive fused salts or liquid metals are described in Bulletin 10-57. 4 pages. Hoke, Inc., 136 S. Dean St., Englewood, N. J. D

Circle 566 on Page 19

Solid Film Lubricants

Eight different solid film lubricants and their respective applications are subjects of Catalog LB-6-1157. They will solve lubrication problems with pressures ranging to 225,000 psi, speeds to 30,000 rpm, and temperatures from − 300 to 1500° F. 16 pages. Electrofilm, Inc., Box 106, North Hollywood, Calif. L

Circle 567 on Page 19

Signalling Controller

Used to detect condensate purity, measure capacity loss in ion exchangers, and for acid control in mercerizing and carbonizing baths, the Electromax signalling controller employs electrolytic conductivity cells at the point of measurement. Full information on this instrument is given in Bulletin ND47-95(1). 2 pages. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 4, Pa. E

Circle 568 on Page 19

Frequency Changer

Usable in test equipment over a frequency range of 45 to 2000 cps, the Model FCR100 frequency changer is an ideal power supply for equipment drawing up to 100 va. Technical data sheet gives specifications. 2 pages. Sorenson & Co., Richards Avenue, South Norwalk, Conn. B

Circle 569 on Page 19

Stream Splitters

Complete information is given in Bulletin 137-B on the Sprout Waldron/Richmond splitter for dividing a single stream of dry free-flowing material up to ¼-in. ring size into two to eight separate streams. 2 pages. Sprout, Waldron & Co., 130 Logan St., Muncy, Pa. E

Circle 570 on Page 19

Time Delay Relays

Bulletin AWH TD-502 catalogs various models of subminiature, hermetically-sealed time delay relays. Specifications and performance figures are tabulated. A. W. Haydon Co., Waterbury, Conn. B

Circle 571 on Page 19

Extruded Copper & Brass

"Revere Extruded Shapes: Copper, Brass, and Other Copper Base Alloys" is title of color-illustrated guide to these materials. Sixteen case histories are cited to show application economies. Extrusion process is explained, and properties of various metals and alloys are tabulated. Machining and processing techniques are described. 44 pages. Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y. C

Circle 572 on Page 19

Universal Joints

Details of ⅜ to 4-in. universal joints for power transmission are given in bulletin. Standard and custom-built joints for aircraft, automotive, machine tool, marine, and other applications are described. 4 pages. Borgeson Mfg. Co., Box 116, Torrington, Conn. B

Circle 573 on Page 19

Servos & Synchros

Illustrated catalog contains design and application data on servo motors, motor-generators, and synchros for 60 and 400-cycle operation. Gear ratios available are listed. 22 pages. Daystrom Transicoil Corp., Worcester, Montgomery County, Pa. E

Circle 574 on Page 19

Hydraulic Hose & Fittings

Rubber-covered, double wire-braided hose and reusable Hoze-log fittings for hydraulic service are subjects of illustrated Catalog 4430. Included are stainless steel braided hose for nonmagnetic service and perforated cover hose for coal shooting. Hose sizes range from 3/16 to 2 in. 8 pages. Parker-Hannifin Corp., Parker Fittings & Hose Div., 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 575 on Page 19

High Frequency Transistors

Maximum ratings, cut-off and small-signal characteristics, and charts of common emitter output static characteristics are given in illustrated Brochure G-150 on high frequency transistors. 12 pages. General Transistor Corp., 91-27 138th Pl., Jamaica 35, N. Y. D

Circle 576 on Page 19

Electron Microscope

How the electron microscope works, and general enginering data on this research and development instrument are presented in illustrated folder. Application information on the new Model EM-75B electron microscope is included. 6 pages. Philips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mount Vernon, N. Y. D

Circle 577 on Page 19

Investment Castings

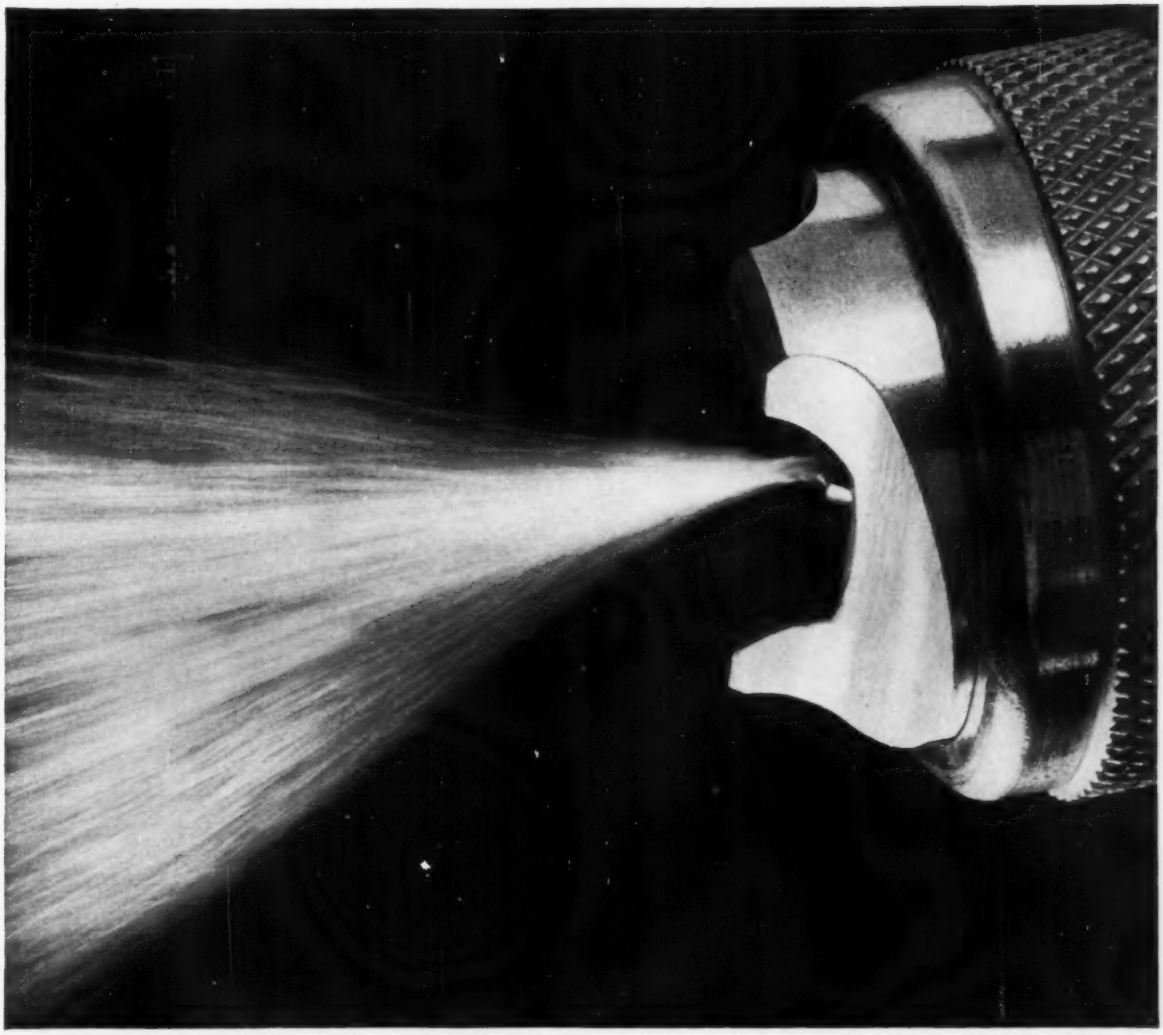
Design information relating to investment castings is presented in illustrated guidebook. Such factors as fillets, holes, threads, wall thicknesses, and tolerances are covered. One section deals with ferrous and nonferrous alloys which are usable for precision investment castings. 8 pages. Casting Engineers, Inc., 2323 N. Bosworth Ave., Chicago 14, Ill. J

Circle 578 on Page 19

Steel Bar Products

Offered as a guide to the proper selection of cold finished bar products, illustrated brochure contains tips and technical data on carbon, free-machining, stress-relieved annealed, leaded, alloy, and stainless steels. Information is included on carbon corrections; special sections; turned,

EC-1357 by 3M Sprays on Smoothly for Stronger Sandwich Bonds!



3M ADHESIVE EC-1357 MINIMIZES COBWEBBING IN SPRAY APPLICATIONS FOR BETTER SURFACE-WETTING, FAR BETTER ADHESION.

Solvent blending makes the big difference! Exact amounts of several solvents are skillfully mixed to achieve the precise blend required for a superior sandwich-bonding adhesive. The result: spray application is easier, greatly reduced cobwebbing saves materials, better surface-wetting provides far better skin-to-core adhesion.

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Circle 468 on Page 19

The *Work-Horse* of Mechanical Seals

For the long haul on heavy-duty sealing jobs —specify the engineered mechanical seal with the greatest record of service on processing equipment . . .

FOR FURTHER INFORMATION WRITE FOR CATALOG NO. 480-MD

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

Circle 469 on Page 19

ground, and finished bars; and furnace treatments. 30 pages. Republic Steel Corp., Union Drawn Div., Massillon, Ohio. F

Circle 579 on Page 19

Pressure Gages

Pressure gages with ranges from 15 psi or 30 in. of vacuum to 20,000 psi are described in Catalog G-58. Included is enginering data section and selection information. 48 pages. Kunkle Valve Co., 120 S. Clinton St., Ft. Wayne 2, Ind. J

Circle 580 on Page 19

Hydraulic Oils

Bulletin B-4 is entitled, "Hydraulic Fundamentals and Industrial Hydraulic Oils." This introduction to hydraulic systems contains explanations of important types of valves, pumps, motors, torque converters, and accessories. Important oil characteristics are discussed. 44 pages. Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa. E

Circle 581 on Page 19

Optical Measuring Equipment

How Scan-A-Scales are used on any production or inspection equipment requiring accurate, reproducible linear settings is explained in Catalog SAS LM54. This optical measuring instrument provides vertical, longitudinal, or crosswise settings to 0.001 in. 6 pages. F. T. Griswold Mfg. Co., 315 Lancaster Ave., Wayne, Pa. E

Circle 582 on Page 19

Viewing Windows

Visual observation of oil supply and operation of internal machine parts are uses for window units described and illustrated in Bulletin 8-E. Level, standard, and open types are covered. Sizes range from $\frac{5}{8}$ to $3\frac{1}{4}$ in. 4 pages. Bijur Lubricating Corp., Rochelle Park, N. J. D

Circle 583 on Page 19

Planned Product Services

"Planned Products" bulletin outlines creative engineering techniques for industry offered by this firm. Six services are discussed: Technical survey, research and development, design and production engineering, industrial design, and transition manufacturing. 4 pages. Designers for Industry, 4241 Fulton Parkway, Cleveland 9, Ohio. G

Circle 584 on Page 19

Instruments & Timers

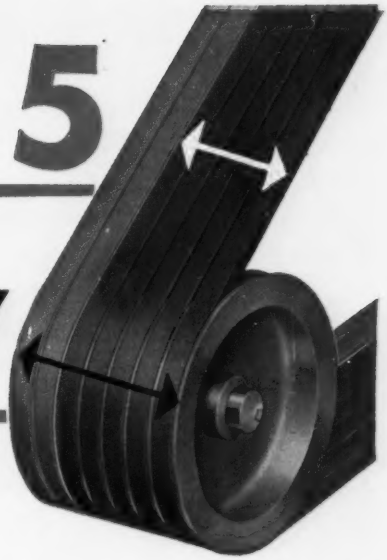
Mechanical timers, instruments, and precision parts production facilities and operations are shown in illustrated brochure. Short company history is included, along with photos of products. 8 pages. Precision Products, Inc., 530 S. Quaker, Tulsa 20, Okla. I

Circle 585 on Page 19

Specialty Steels

Application of specialty steels for the heavy construction and mining industries is subject of illustrated Bulletin ADV

Drive with 5 instead of 7



Use fewer V-belts... get equal horsepower
Save space and costs

You cut sheave width and weight . . . you save in overall costs . . . by using Gates Super Vulco Ropes with 40% more HP capacity. Five Supers actually do the work of 7 standard V-belts.

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The Gates Rubber Company
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Gates — The Mark of *Specialized* Research

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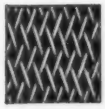
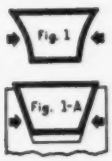


1. Flex-Weave Cover (U.S. Pat. 2519590)
A Gates exclusive: provides greater flexibility with far less stress on fabric. Cover wears longer... increases belt life...more power available to driven machine.



2. Concave Sidewalls (U.S. Pat. 1813698)
Concave sides (Fig. 1) increase belt life. As belt bends, concave sidewalls become straight, making uniform contact with sheave groove (Fig. 1A). Uniform contact means less wear on sides of belt... far longer belt life.

3. Tough, resilient Tensile Cords
Super-strong resilient tensile cords provide 40% greater horsepower capacity ...easily absorb heavy shock loads... reduce number of belts required... save weight and space.

4. High Electrical Conductivity
Built into Gates Super Vulco Ropes for safer drives (in explosive atmospheres).

5. Oil, Heat, Weather Resistant
Special rubber compounds make Super Vulco Ropes highly resistant to heat, oil, and prolonged exposure to weather.

TPA 306

Gates Super VULCO ROPE Drives
40% more Horsepower Capacity

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There is untapped productive potential in the existing machinery in most plants. When these same machines are equipped with the Sterling Electric Power Drive System, recommended by a Sterling Application Engineer, you will get the full productive capacity they were designed to deliver.

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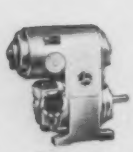

Speed-Trol Variable Speed Drives

Sle-Speed Gear Motors

Constant Normal Speed Motors

Multi-Mount Speed Reducers

186. Various grades of alloy, carbon, drill, stainless, and tool steels, plus castings, welding electrodes, magnets, springs, and tool bits are discussed. 8 pages. Crucible Steel Co. of America, Oliver Bldg., Pittsburgh 22, Pa. F

Circle 586 on Page 19

Preplated Metals

Illustrated folder covers C-Grade steel-base, preplated metals—offered with chrome, nickel, and copper finishes in sheets, coils, and strips. 8 pages. American Nickeloid Co., Peru, Ill. I

Circle 587 on Page 19

Cork Gasket Material

Uniphase cork gasket material, described and illustrated in Bulletin IND-1050, combines impermeability, conformability, and chemical intertness. Its features, characteristics, and applications are covered. 16 pages. Armstrong Cork Co., Industrial Div., Lancaster, Pa. C

Circle 588 on Page 19

Temperature Controls

Nine types of temperature controls, including cartridge type Thermoswitch units, midget and miniature models for "tight-spot" use, surface mounting and high current capacity designs, Detect-A-fire units, two thermistor controllers, and a mechanical indicating controller are described in Catalog MC-156. Ratings are given. 4 pages. Fenwal Inc., Pleasant Street, Ashland, Mass. B

Circle 589 on Page 19

Direct Current Motors

Totally-enclosed, direct-current motors with air-to-air heat exchangers are detailed in Bulletin 53 B 8904. Ratings are from 10 to 200 hp. Design features, cooling system details, and dimensions for all models are included. 4 pages. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. K

Circle 590 on Page 19

Expanded Metal Meshes

Three small-mesh, expanded metal patterns are described in illustrated Folder 516-EM. Multimesh patterns are offered in two or three different size openings and shapes recurring in the sheet. Gages, weights, and dimensions are included. 4 pages. Penn Metal Co., 40 Central St., Boston 9, Mass. B

Circle 591 on Page 19

Retractile Cords

Revisions in Koiled Kords Catalog 582 include simplification of tabular matter giving types, sizes, and colors available. Illustrations show many uses for retractile cords in communications and industry. 16 pages. Koiled Kords, Inc., Box K, New Haven 14, Conn. B

Circle 592 on Page 19

Cold Roll Forming

Clear, concise discussion of the economics, mechanics, and possible applications of the cold roll forming process in producing a wide variety of metal

Circle 471 on Page 19

NATIONAL OIL SEAL LOGBOOK

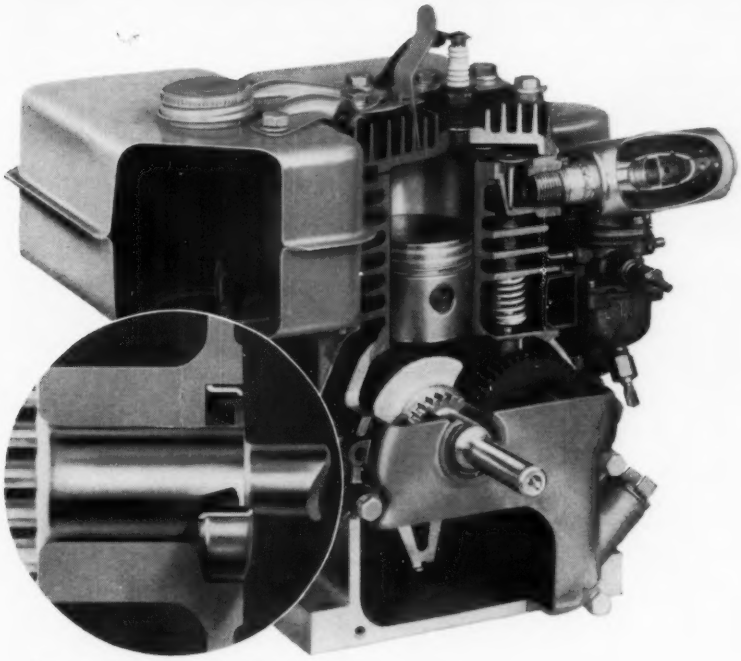


Figure 1. National 50,000-S Syntech Seal

Zero leakage oil sealing a "must" in Briggs & Stratton 2¾ hp engine

Some oil sealing applications can accept a small amount of lubricant leakage or "seepage." But not the Briggs & Stratton 8B Engine. Here, on a ⅞" crankshaft turning up to 3,600 RPM, light engine oil must be positively sealed in the crankcase at both front and rear bearing points. Oil temperature is 200° F with the engine at wide open throttle; and external temperatures may range from —30° to 125° F. Many Briggs & Stratton 8B engines operate only after long periods of inactivity; others are used continuously, a variable which makes the sealing problem even more demanding.

Satisfactory sealing and long, trouble-free service life is obtained by use of two special National Syntech® synthetic rubber seals (Fig. 1)—one at either sealing point. These precision made Syntechs have a minimum-contact sealing lip seating lightly but firmly on the shaft. The steel outer case is a precise press-fit for the bore, simplifying installation and preventing accidental working free of the seal.

National pioneered Syntech synthetic rubber seals; today offers a complete line of Syntech and leather seals plus convenient, competent oil seal engineering assistance. For data, for practical design help, call the National Seal engineer. He's under Oil Seals, in the Yellow Pages.

Variations on basic oil seal designs

10,000-S

Many modifications of the basic National spring-loaded Syntech oil seal design are offered. For example, where external conditions require a felt dust baffle, National 10,000-S may be employed. Where dirt or grit conditions are severe, a National 20,000-S with leather or Syntech auxiliary sealing lip is often used.

230,000-S

For applications where shaft entry is made from the auxiliary side, a National 230,000-S seal with auxiliary leather washer-type sealing lip mounted *in tandem* is suggested.

70,000-S

For positive separation of low viscosity fluids at higher speeds and temperatures, National 70,000-S series seals are suggested. Basically two 50,000-S seals mounted with sealing lips opposed, this seal may be used at temperatures above 250° F and speeds in excess of 2,000 FPM.

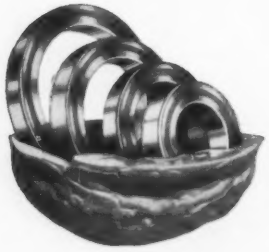
Altogether, National offers over 2,500 basic types and sizes. There is one best seal for a given application. Your National engineer can help you obtain it.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California;
Plants: Van Wert, Ohio, Downey and Redwood City, California

4628

Circle 472 on Page 19



in a nutshell

ACTUAL SIZE

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improve performance in
instruments, electromechanical devices,
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by using these
SBB Midget T Series ball bearings.
Minimal cross sections,
maximum ball complements,
plus one-piece retainer,
continuous shoulders
(no loading notches)
combine to give you greater
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301 HIGHWAY FOUR, LEBANON, N. H.

Circle 473 on Page 19

shapes is included in manual "Cold Roll Forming." Production costs, operating speeds, tooling, surface finish, forming of precoated stock, and personnel training are among subjects covered. "How to" instructions are included. 88 pages. Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio. G

Circle 593 on Page 19

Rubber & Metal Hose

Flex-O-Tube rubber and synthetic hose and Rex-Weld flexible metal hose are described in illustrated Catalog 173. Former is made in high, medium, and low pressure types. Several types of fittings and couplings are also covered. Metal hose is offered in several metals with couplings. 8 pages. Flexonics Corp., 1315 S. Third Ave., Maywood, Ill. J

Circle 594 on Page 19

Mill Motor

Electrical and design features of the Elliott Crocker-Wheeler 620 frame mill motor are detailed in Bulletin PB-9000-2. Four types of enclosures are offered. Ratings are 275 and 350 hp and speeds range from 370 to 390 rpm. 4 pages. Elliott Co., Jeannette, Pa. G

Circle 595 on Page 19

Flow Regulator Valves

Combination by-pass and restrictor type flow regulator valves with built-in relief valves are subject of catalog sheets which include drawings and engineering information. Valves minimize fittings in hydraulic circuits. Fluid Controls, Inc., 1284 N. Mentor Ave., Mentor, Ohio. F

Circle 596 on Page 19

Worm Gear Jacks

Capacities from 2 to 100 tons and raises from 3 to 24 in. are available in Series 1800 worm gear jacks. Described in illustrated Bulletin AD-66, they have worm gear ratios from 6:1 to 36:1. Dimensional drawings, and applications are shown. 8 pages. Duff-Norton Co., Pittsburgh 30, Pa. F

Circle 597 on Page 19

Electric Heating Units

Extensive line of electric heating units and equipment is described in detail in illustrated Catalog 50. Included are strip, finstrip, tubular, and cartridge elements, immersion and circulation heaters, hot plates, thermostats, melting pots, and contactors. Engineering data are included. 48 pages. Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa. G

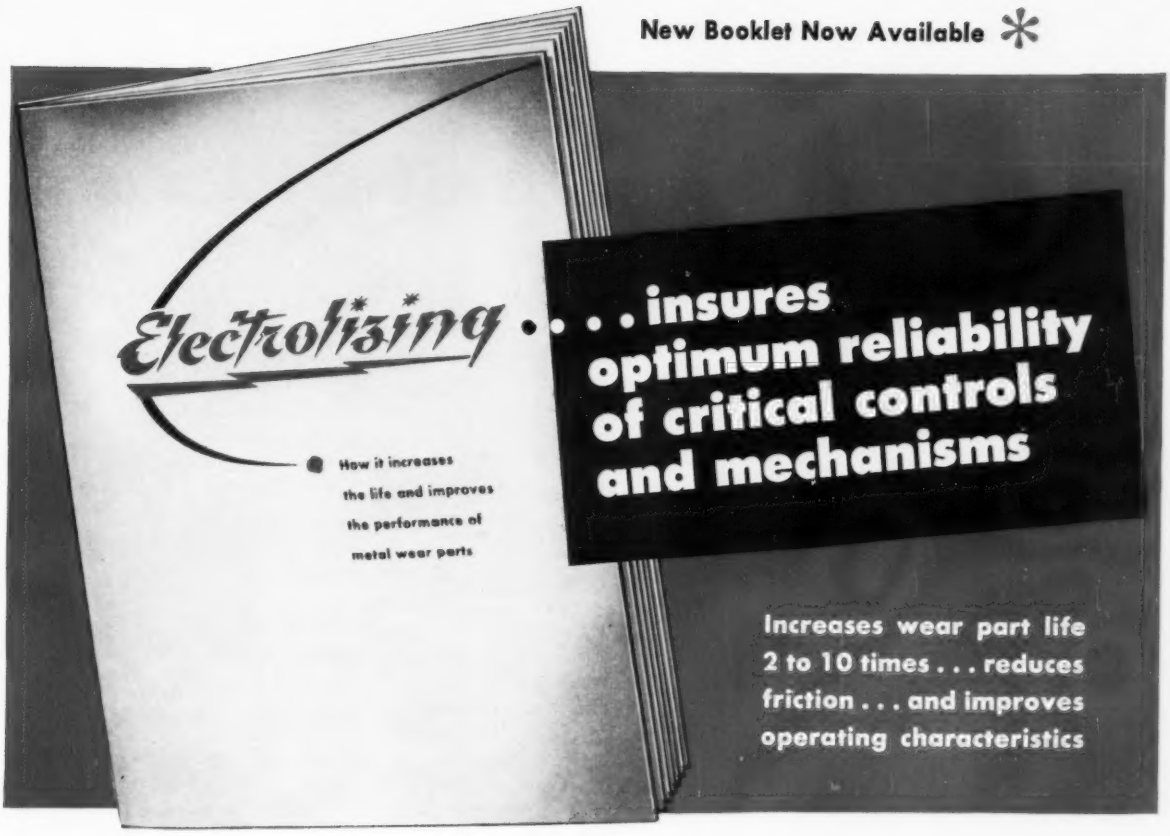
Circle 598 on Page 19

Tubed Sheet

Roll-Bond process described in illustrated brochure allows a designer to create any pattern of tubing, however intricate, within a single homogeneous sheet of metal. Step-by-step procedure is described and illustrated and application data are covered. 8 pages. Olin Mathieson Chemical Corp., Western Brass Mill Div., East Alton, Ill. I

Circle 599 on Page 19

New Booklet Now Available *


Electrolizing
How it increases the life and improves the performance of metal wear parts
. . . insures optimum reliability of critical controls and mechanisms
Increases wear part life 2 to 10 times . . . reduces friction . . . and improves operating characteristics

How Electrolizing Insures Reliability:

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Circle 474 on Page 19

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Ball-Way Cartridges

eliminate breakaway friction on machine-tool parts

New ball-way cartridges virtually eliminate breakaway friction on horizontal sliding tables and other machine-tool parts. Cartridges are attached to and made a part of the moving unit. Balls are recirculated within the cartridge, and number of cartridges used depends on length and weight of moving part and

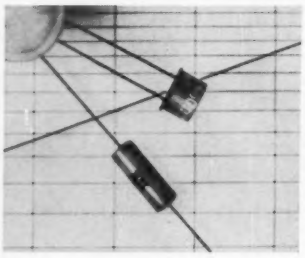
support needed. Cartridges can be shimmed and adjusted for maximum system stiffness. **Beaver Precision Products Inc.**, 651 Rochester Rd., Clawson, Mich. H

Circle 600 on Page 19

Silicon Resistor

has large positive temperature coefficient

New solid state silicon resistor, designated Sensistor, has 0.7 per cent per deg C positive temperature coefficient of resistance. It responds to an increase in temperature with an increase in resistance that rises rapidly along a stable, retraceable characteristic curve. Applications include use as a temperature-compensating device in miniaturized amplifiers, servos, computer switching circuits, magnetic amplifiers, and power supplies. It is also useful as a temperature-sensing element for automatic controls, and other precise temperature-indicating applications. TM



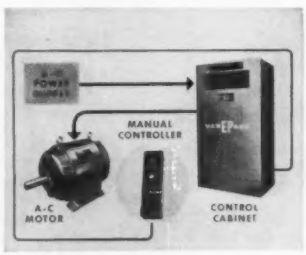
1/4 (bottom) is an axial-lead, molded device which is linearly derated at full load from 100 to 150 C. TC 1/8 (top) is encased in a round-welded package and is derated linearly at full load from 125 to 200 C. Both units are available in standard resistance ratings from 100 to 1000 ohms at 25 C. **Texas Instruments Inc.**, P. O. Box 312, Dallas, Tex. I

Circle 601 on Page 19

Adjustable-Speed Drive

in ratings from 1 to 50 hp

New drive for three-phase, wound-rotor, induction motors provides infinitely adjustable speed by means of ac electronic control. Designated VarEPack, drive uses 1 to 50-hp motors and provides maximum speeds of 3400, 1700, 1130 rpm or less. Drive is connected directly to the load, eliminating belts or clutches. Consisting of ac induction motor, control station, and control cabinet, drive requires no commutators. Thyratron tubes act as an impedance control. Failure



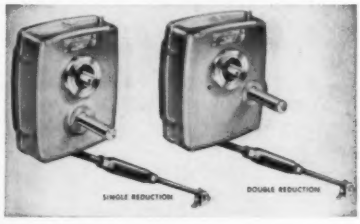
of one or more thyratrons does not render system inoperative. Internal coaxial fan, driven by magnetic field of main motor, operates at a speed proportional to motor current and provides cooling in proportion to need. **Electric Products Co.**, 1725 Clarkstone Rd., Cleveland 12, Ohio. G

Circle 602 on Page 19

Speed Reducers

shaft-mounted units incorporate lifetime gearing

Duti-Rated shaft-mounted speed reducers with capacities from 1/4 to 40 hp are available in shaft sizes from 1-7/16 to 3-7/16 in. They incorporate lifetime gearing to provide excellent power-transmission efficiency and long service life. Reducers are equipped with adjustable torque arms, and can be supplied with or without enclosed backstop. Single and double-reduction types are offered with output speeds from 10 to 420 rpm at 1750 rpm



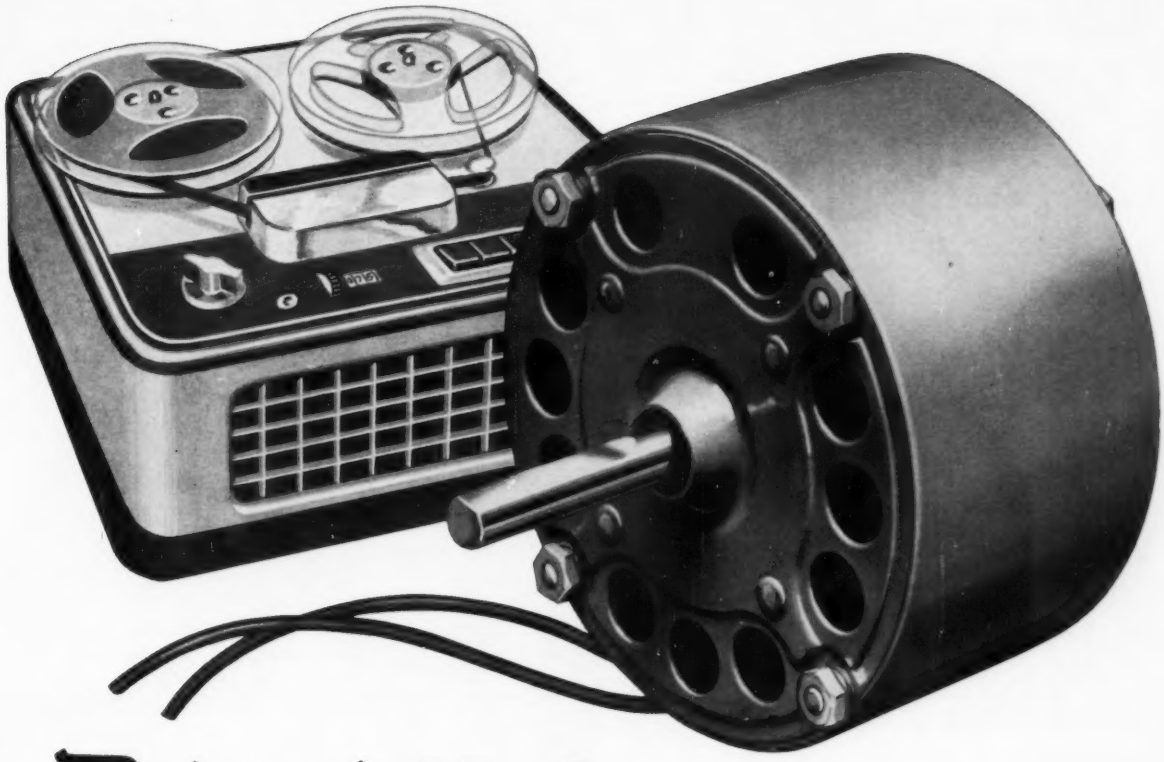
input using standard V-belt drives. **Foote Bros. Gear & Machine Corp.**, 4545 S. Western Blvd., Chicago, Ill. I

Circle 603 on Page 19

Quartz Tubing

in almost any polygonal shape

Quartz tubing is now available with square, triangular, hexagonal, and other noncircular cross-sections. Applications include use in the pro-



Redmond AL-4

Meets The Exacting Demands For Tape Recorders

Or Any Application Requiring An Economical, Compact, Lightweight, Quality Motor

The motor in a tape recorder and other high quality high fidelity equipment has to be smooth-running and whisper-quiet in operation. It must meet all "wow and flutter" specifications, and give years of trouble-free service. That is why leading manufacturers in this industry are now using thousands upon thousands of Redmond AL-4 MicroMotors.

The AL-4 is designed for a wide variety of applications, or it can be tailor-made for specific requirements. It is designed and styled to meet the modern demands for motors that are smaller and lighter, and yet have increased output. Besides tape recorders, it is widely used for portable washers, kitchen ventilators, ice crushers, fans, and dozens of other applications.

This modern motor can save money on a host of applications where economy is a factor and yet high quality is needed.

There is a Redmond sales engineer in your area who wants to help you adapt the AL-4 to your motor needs. Write, telephone, or wire us at Owosso, and we will have him contact you at once.

SEND FOR COMPLETE PERFORMANCE DATA

For the complete story on the new AL-4 motor—dimensions, performance, operational data, and suggested applications—write for the "AL-4 Bulletin."

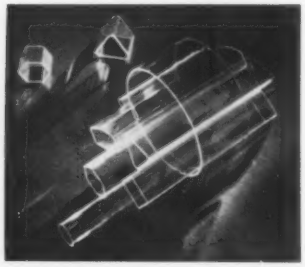
The Standard of Dependability

Redmond COMPANY, INC.

OWOSSO, MICHIGAN

ADVERTISED IN The Saturday Evening POST

THE **BIG** NAME IN SMALL MOTORS



duction of semiconductor transistor instruments, and as insulators or liners for radio and other electronic components. Product is essentially free of boron impurities. Tubing is supplied in lengths to 6 ft or more. Special shapes can be manufactured to specifications, with maximum dimensions up to 2 in. per side on a square. **Lamp Glass Dept., General Electric Co.,** Nela Park, Cleveland 12, Ohio. F

Circle 604 on Page 19

Nuts and Washers

preassembled units have ¼-in. across-flats dimension

No. 4, No. 5, and No. 6 Keps, preassembled nuts and lock washers, have standard No. 4 across-flats dimension of ¼ in. Because of the ¼-in. dimension, the No. 6 Keps uses the same socket wrench as that used for a No. 6 hexagon-head screw, speeding up assembly operations where both screws and nuts in No. 6 size are used. Ad-

ditional sizes increase line range from No. 4 to ⅜ in. **Shakeproof Div., Illinois Tool Works,** St. Charles Road, Elgin, Ill. J

Circle 605 on Page 19

Metal O-Ring

is Teflon coated

New Teflon-coated metal O-ring for applications in the aircraft and industrial fields provides effective sealing at temperatures as low as −300 F. Resilience of metal O-ring plus physical properties of Teflon eliminate cold flow when subjected to high pressures. Rings are available in all standard sizes and can be used in grooves designed for plain metal O-rings. **Advanced Products Co.,** 59 Broadway, North Haven, Conn. B

Circle 606 on Page 19

Safety Relief Valves

for pressures to 12,000 psi

Series 44 valves are made of materials compatible to helium, nitrogen, liquid oxygen, red fuming nitric acid, and other caustic solutions and gases. They are for use with pressures to 12,000 psi. Inlet connections are Aminco superpres-

sure, AND, or NPT type. Two sizes are available, No. 44-1 for up to ¾ in. NPT equivalent, and 44-2, for up to 1 in. NPT equivalent. **Fluid Mechanics Co.,** P.O. Box 194, Bellaire, Tex. I

Circle 607 on Page 19

Phenolic Laminate

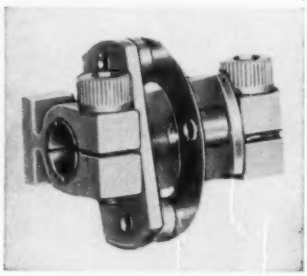
paper-base material has low dielectric loss

Grade 320 paper-base phenolic laminate is for use in critical electrical and electronic circuits. Material meets MIL-P-3115, type PBE-P specification. It provides low dielectric loss, high dimensional stability, high insulation resistance, and high surface resistivity. Mechanically strong, laminate resists fungus growth and maintains electrical characteristics after prolonged exposure to high humidity. Applications include use in television tuners and carbon-coated resistors, as resistor cards, and for terminal and connector strips. Laminate is available in sheets approximately 49 x 49 in. and thicknesses from 0.020 through 1.0 in. Light in color, material has a semi-gloss surface finish and medium translucency. **Taylor Fibre Co.,** Norristown, Pa. E

Circle 608 on Page 19

Disc Couplings

are free of backlash



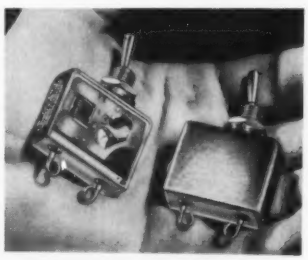
Coupling of shafts in angular misalignment up to 2 deg can be effected with new disc couplings consisting of a flexible disc riveted to a pair of precision hubs. Entirely free of backlash, units are suitable for servo applications requiring high transmission accuracy. They accept ¼-in. shafting, and are available in models for either clamp or pin fastening. Units can be operated at speeds up to 5000 rpm with maximum transmitted torque of 50 oz-in. **Commercial Products Dept., Reeves Instrument Corp.,** Roosevelt Field, Garden City, N. Y. D

Circle 609 on Page 19

Circuit Breaker

miniature unit weighs only 2.1 oz

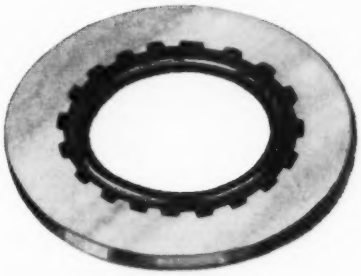
Model SM3 hermetically sealed circuit breaker is for applications where small size, light weight, and stable performance under varying conditions of shock, vibration, and ambient temperature are required. A series-overload breaker, unit operates at 110 v, 60 or 400 cycles, or at 50 v dc. Weighing only 2.1 oz, it is available in ratings from 50 ma to 10 amp. Two time-delay



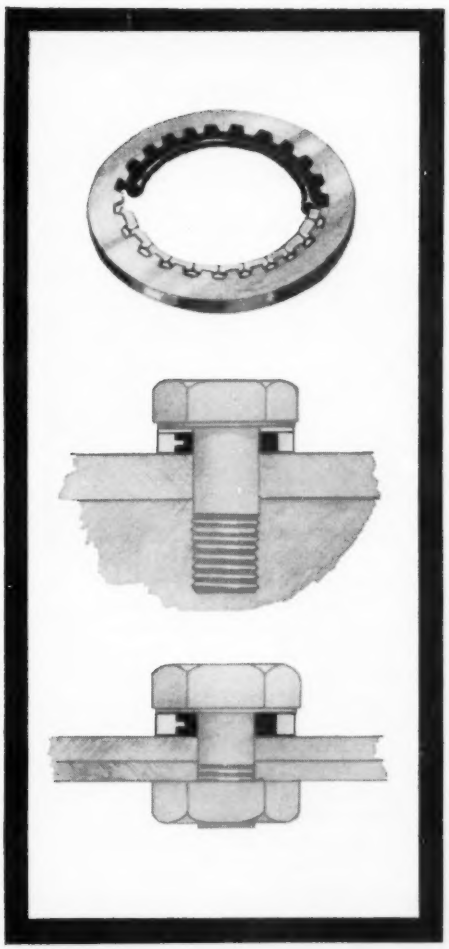
FOR SEALING-

NOW IT COSTS NO MORE

FOR THE SUPERIORITY OF



Stat-O-Seal®



Only Stat-O-Seals offer safe, sure, effective sealing using the principle of controlled confinement of the seal plus the advantages of *mechanical* "bonding".

This means they will not "twist" in installing and there is no chemical bonding agent that can be attacked by corrosive fluids. Stat-O-Seals feature:

- Metal to metal contact of faying surfaces
- Quick, visual inspection
- Easy, one piece, "twist-free" assembly
- Re-useability
- O-ring style configuration for versatility and freedom from easy damage
- Sure sealing from high vacuum to 20,000 PSI
- Standard sizes for bolts and nuts from −6 to 2" and types to seal almost any fluid at temperature ranges from −85° to +360°F.

Stat-O-Seals have been proven in thousands of vital installations and now they cost no more than ordinary seals for similar purposes.

If your product and designs require seals, why not find out how Stat-O-Seals can do a better job for you, too.

by the makers of Gask-O-Seal *and Met-O-Seal*

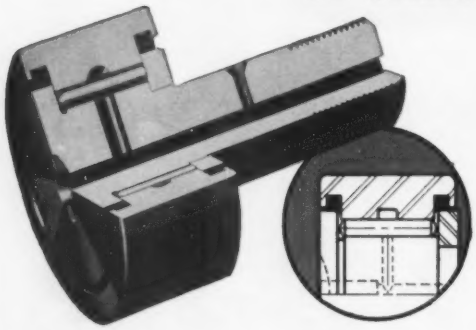
Parker
SEAL COMPANY*
CULVER CITY, CALIF. • CLEVELAND, 12, OHIO
A DIVISION OF Parker Hannifin CORPORATION

**Formerly Franklin C. Wolfe Co. and Parker Rubber Division*

Circle 476 on Page 19

BEARING TIPS by McGill

sealed CAMROL® bearings lock out contamination in critical cam follower applications

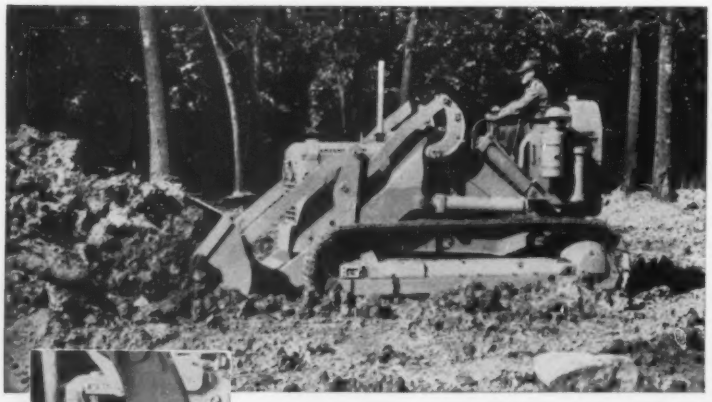


Now Sealed and Prelubricated

The new SCF series of the famous CAMROL cam follower completely seals out dirt, chips, moisture, etc. — an important advantage where the life of an ordinarily open mounted cam follower can be materially increased with adequate protection against contamination. Also the sealed bearing is pre-lubricated with provision made for easy re-lubrication, if desired, through either end of the stud.

Specially treated synthetic seals are contained in the outer race undercuts over the stud flange and roller retaining washer. For added protection, all external surfaces of the bearing are treated to provide a corrosion resistant, black ferrous oxide surface.

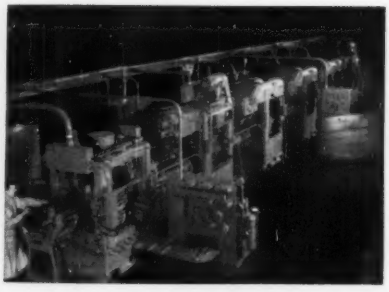
These same advantages are available in the SCYR sealed series Cam Yoke Roller (without stud). Specify CAMROL bearings with the built-in seals that preserve cam follower dependability in critical cam action, support or track roller application.



Built-in seals protect and preserve CAMROL® bearings from contamination in CATERPILLAR-built TRAXCAVATORS®

McGill SCF series sealed CAMROL bearings provide the cam action that positions the bucket of the No. 977 Traxcavator unit at the selected digging angle. Mounted on bell crank arms that are actuated by contact with a cam shoe on a hydraulic cylinder linkage, these bearings are operating in the open and exposed constantly to dust, dirt and moisture. External surfaces have a black ferrous-oxide finish to prevent corrosion. These sealed McGill cam followers eliminate the need for relubrication and maintenance after installation. Caterpillar uses other McGill bearings including twelve CYR series cam yoke roller bearings in the flywheel clutch.

378 sealed CAMROL® bearings guide engine blocks in INGERSOLL automatic milling machine



The sealed CAMROL bearings used in this machine, guide cylinder blocks during transfer through various milling, boring and drilling operations. The bearings, used in place of guide bars, eliminate surface scratching of the 200 to 300 pound blocks which are transferred at speeds up to 400 feet per minute. Blocks are processed at the rate of 95 per hour. Ingersoll reports freer movement, accuracy of positioning and materially longer bearing life due to the new design that seals metal chips out of the bearings.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

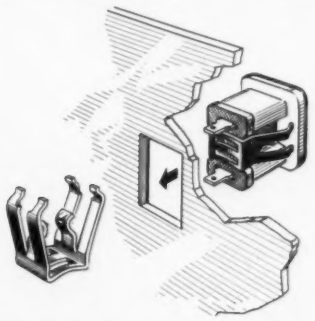
curves are offered for fast or slow overload response, and breaker is also available with instantaneous-trip response. Temperature range is −65 to 125 C. **Heinemann Electric Co.**, 572 Plum St., Trenton 2, N. J. E

Circle 610 on Page 19

Spring-Steel Fastener

fastens convenience outlets to appliance splasher panels

Dual-purpose Speed Clip has four spring fingers which allow fast assembly of ceramic convenience outlets to splasher panels of stoves and other appliances. The spring-steel unit is totally self-retaining on the outlet. Center spring finger on either



side of fastener snaps down over sides of outlet, and squared barbs sink into retaining holes. Positive spring lock is provided, and insulating washer, which retains and separates contacts, is held firmly in position. Re-usable clip permits easy removability of the outlets, wide range in panel thicknesses, and prevents vibration loosening. **Tinnerman Products Inc.**, P. O. Box 6688, Cleveland, Ohio. F

Circle 611 on Page 19

Dashpot Cylinder

for use with pneumatic actuators

Martonair check unit is a hydraulic dashpot cylinder which permits restricted rate of movement in one direction and free movement in the other. It is for use in conjunction with pneumatic cylinders powering tool feeds, drill feeds, and turnover devices. Of concentric construction, cylinder has a small compensating unit at one end and has no external piping or connections. Flow rate is variable by means of

you benefit

7 BIG WAYS

when you call your

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Roller Chains and Sprockets

For the finest in roller chain and the best of service . . . call your local Acme Industrial Distributor whenever you need any kind of chain information, parts, or engineering service.

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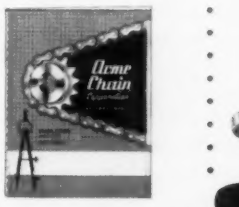


Write Dept. 6-Q for new 100-page Illustrated Catalog, including new engineering section showing diagrams of 36 methods of chain driving.

Call ACME for Service

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

Circle 478 on Page 19

Perfection Worm Gear Speed Reducers by American Stock Gear are available in 9 complete series with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute. Speed Reducers are furnished in horizontal right angle drive with worm in either top or bottom position and are also furnished in vertical right angle drive. Integral worm and shaft is made of selected quality, case hardened alloy steel. Threads are precision ground and accurately mated with worm gear. Shafts are mounted in Timken anti-friction roller bearings. Heavy rigid cast-iron housings . . . easily accessible oil filling level and drain plugs are provided for oil reservoir. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor.

Write for new 16 page catalog covering the complete PERFECTION Speed Reducer line.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY • HARVEY, ILLINOIS, U.S.A.

a screw secured by a lock nut. Four models are available with strokes of 3, 6, 9, or 12 in. Maximum load capacity is 1200 lb. **Lehigh Inc.**, Old York Road, Lambertville, N. J. E

Circle 612 on Page 19

Magnetic Rubber

produces either weak or strong magnetic fields

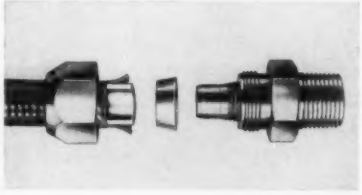
Denmag, a magnetic rubber used to handle ferrous materials and parts in the metal-producing, metal-processing, and metal-fabricating industries, is produced by compounding neoprene or other rubber and plastic substances with various permanent magnetic materials of small particle size. It is easily fabricated into different shapes so that materials of different cross-section can be handled. Rubber can be compounded to produce either strong or weak magnetic fields as required. Magnetism is applied in a variety of patterns to facilitate handling and tracking. Material provides low-density magnetic flux over a large area. It is well suited for handling square, rectangular, or odd-shaped metal pieces such as oval, circular, trapezoid, and star. Rubber provides a soft surface to avoid marring or scratching parts handled. **Herr Equipment Corp.**, 1416 Vine St., Warren, Ohio. G

Circle 613 on Page 19

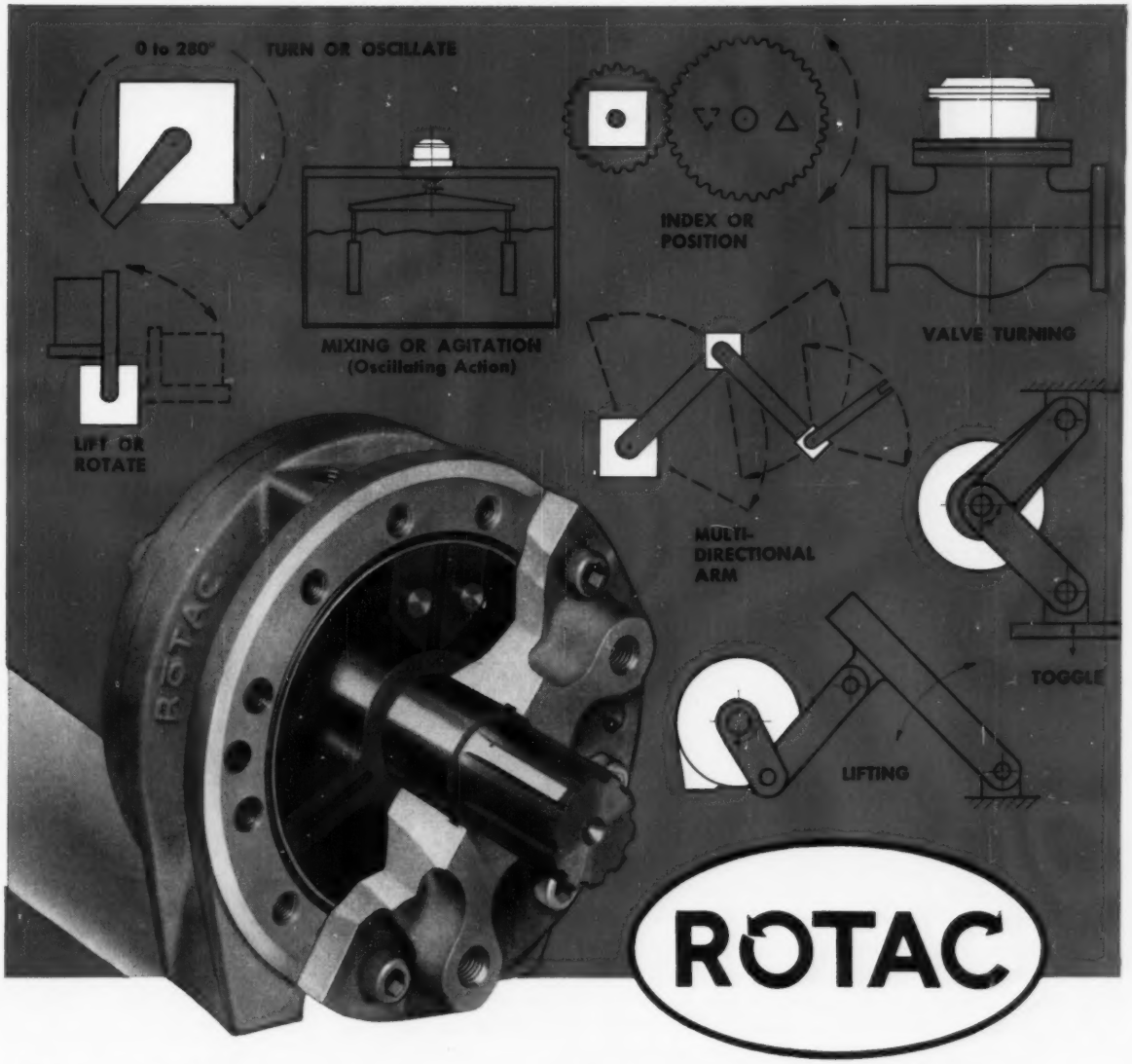
Teflon Hose Assembly

has reusable fittings

Springfield 140 Teflon hose with reusable fittings is reinforced with a stainless-steel wire braid. Hose resists chemicals and corrosion in a temperature range of −100 to 500 F. Reusable fitting consists of



Circle 479 on Page 19



Limitless as your imagination...

Rōtac reciprocating torque actuators provide a positive control for any movement from turning watch parts to tipping railroad cars

Just imagine the virtually limitless applications now easily and economically practicable with Ex-Cell-O precision reciprocating torque actuators. Trademarked Rōtac, these actuators transmit maximum torque per displacement in a vast variety of operations: clamping, indexing, lifting, lowering, revolving, pushing, pulling, opening, closing, swinging, oscillating and turning. Into each Rōtac actuator goes the traditional excellence in design, development and manufacture you have come to expect over the years in every Ex-Cell-O-built product.

XLO
EX-CELL-O FOR PRECISION

FREE—NEW 20 PAGE BROCHURE

If you move *anything*, then you'll want detailed information on Rōtac. Learn how this rotary power is used throughout industry in thousands of applications. Complete with photos, schematics, engineering data, etc.

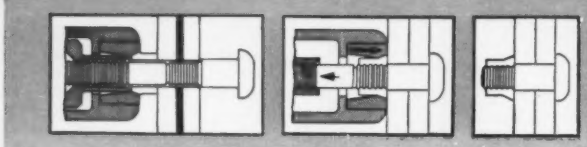
57-60

EX-CELL-O CORPORATION

945 E. SATER ST., GREENVILLE, OHIO

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Circle 480 on Page 19



Pin is inserted and collar placed on tail, gun then engages pull grooves, draws material together and pulls pin into hole. Collar is swaged into locking grooves and pin tail then is broken off at breakneck groove. Action takes place in the time it takes to pull trigger.

This quick demonstration at your desk will show how to get superior, more economical fastening with TOWNSEND LOCKBOLTS*

In a few minutes we can show how Townsend lockbolts will give you superior fastening at lower installed cost and improve your products. A Townsend engineer will demonstrate the ease with which they can be installed, and prove their high resistance to vibration and shock.

Townsend lockbolts provide a higher clinch, or clamping action than rivets, and more uniform fastening than nuts and bolts. They fill the hole better than other fasteners, have high tensile pre-load, make a more rigid joint and provide an effective liquid seal. Available in both steel and aluminum alloy in a variety of diameters and lengths—two head styles.

For a demonstration of how Townsend lockbolts will improve your fastening while lowering the cost, write to Townsend Company, P.O. Box 237-E, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Circle 481 on Page 19

compression nut, tapered ring, and nipple insert. Insert, only part of assembly in contact with fluid, is of stainless steel. Assembly sizes range from 1/4 to 3/4 in., and include JIC and SAE fittings. Hose and fittings can be used with hot solvent, tar, and chemicals. **Titeflex Inc.**, 508 Hendee St., Springfield 4, Mass. B

Circle 614 on Page 19

Worm-Gear Jacks

in eight capacities from 2 to 100 tons

New 1800 Series worm-gear jacks are offered in eight capacities from 2 to 100 tons. They hold heavy

loads in position indefinitely without creep. Eight models have a uniform rate of raise, which permits jacks of varying capacities to be operated in unison on unevenly distributed loads. Raises up to 24 in. can be furnished. Jacks are used on applications such as feeding tables, tube mills, welding positioners, rolling mills, testing equipment, conveyor lines, aircraft jigs, and loading platforms. **Duff-Norton Co.**, P. O. Box 1889, Pittsburgh 30, Pa. F

Circle 615 on Page 19

Multiplier Phototube

is small, dormer-window type

Multiplier phototube 7029 is for detection of low-level, low-contrast light signals in the presence of relatively high background illumination. It incorporates a dormer window through which light is directed onto a semitransparent photocathode located on inner spherical surface of end of bulb. Medium cathode luminous sensitivity is 125 mu amp per lumen. Spectral re-

Circle 482 on Page 19→

DOW CORNING CORPORATION

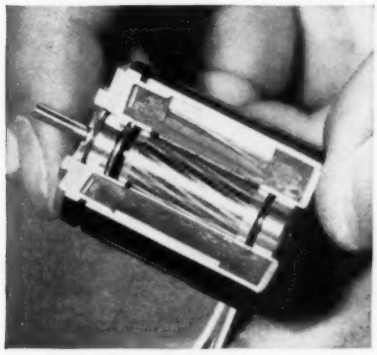
Silicone News

FOR DESIGN ENGINEERS No. 50

"SEAL IN" DEPENDABILITY WITH SILICONE RESIN

Engineers at G-M Laboratories, Inc., Chicago, take no chances on the performance of servo motors intended for high temperature or high humidity service. They virtually "seal in" dependability by impregnating the stator coils with heat-stable, moisture-proof Dow Corning 7501 Resin.

G-M Laboratories, Inc., blends this solventless, silicone resin with a suitable inorganic filler, impregnates the stator coil assembly by vacuum-filling and then cures the unit in an inert atmosphere.



The cutaway photo illustrates how the resin completely fills up the coil interstices and provides a solid, bubble-free mass inside the case. As a result, the *(Cont. Pg. 2)*

NEW LAMINATES WITHSTAND 1200F

Heat-reflective silicone-glass laminated parts that actually repel heat and withstand exposure to temperatures as high as 1200 F are now produced by Swedlow Plastics Company, Los Angeles, for use as heat dams and as light, heat-stable structural parts.

By metallizing one side of the silicone-glass laminate, Swedlow has increased heat reflecting efficiency markedly. When this metallized surface is exposed to 1200 F, the maximum temperature on the other side of the laminate is only 490 F and the air temperature 3/8 inches away is 260 F . . . an overall temperature reduction of nearly a thousand degrees.

Structural parts made from heat-reflective, silicone-glass laminate provide a new level of strength-to-weight at high temperatures. They weigh only 0.530 pound per square foot for 0.0625 inch sections. They are easy to mold, easy to fabricate and are used as heat dams on numerous aircraft. On North American's F-100, for example, this new material has replaced metal shields covered with aluminum foil to protect the wiring in the afterburner area. The new "Heat Reflective Plastic" offers many advantages for applications ranging from missiles to hot water tanks . . . wherever protection from high temperatures is a factor. *No. 506*

Versatile Solenoids More Reliable With Sylkyd Enameled Magnet Wire

New evidence of the high temperature performance possible by using magnet wire coated with Dow Corning Sylkyd* Enamel comes from West Coast Electrical Manufacturing Corporation, Los Angeles, producer of miniature solenoids for aircraft missiles.

West Coast Electrical uses Sylkyd enameled magnet wire on their Wesco A-4, a 4 oz. continuous duty solenoid exerting a three pound pull at a 1/16" stroke. The Sylkyd enameled wire increases reliability and ups allowable ambients to 250 F, permitting total operating temperature of 500 F. By making it possible to locate the unit closer to the work, the solenoid becomes even more versatile.

Their engineers likewise specify Sylkyd enameled wire for the intermittent-duty Wesco A-1, a tiny 2½ ounce unit designed to pull 3½ pounds at 1/16" stroke. Sylkyd's great heat stability increases the operating interval of this unit as much as 70 to 100% and at the same time multiplies its rated service life by five! *No. 507*

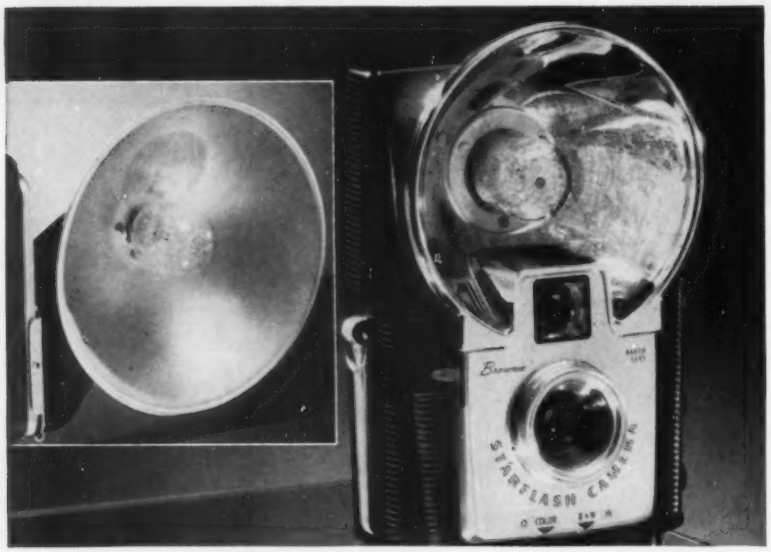
*T.M.REG.U.S.PAT.OFF.

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News



Invisible Silicone Film Protects Reflector Finish

Eastman Kodak has found that an easy and practical way to protect the finish on its newest photoflash reflectors is to apply an invisible but durable silicone film.

The vacuum-metallized plastic surface on Eastman's new photoflash reflectors has far more reflective power than old style satin-finished aluminum units and represents a new high in reflector efficiency.

To assure maximum user benefit, the company has taken every precaution to safeguard this finish. After the reflectors are vacuum-coated, they get a clear coat of varnish which is topped off by a dip in a solution of Dow Corning 200 Fluid.

According to Eastman: "Experimentation has established that a very light application of silicone fluid to the reflector surface reduces finger-printing and increases scratch and abrasion resistance.

"The silicone film is applied by dipping the reflectors in a 0.2% solution of Dow Corning 200 Fluid of 33 centistokes viscosity in low-flash naphtha. The naphtha is allowed to evaporate before the reflectors are packaged."

Excellent wetting and spreading characteristics of Dow Corning 200 Fluid provide a practical means of applying a smooth, continuous, nonoily film that is invisible, dry, heat-stable and water repellent. Its resistance to oxidation makes it an excellent nongumming, durable film. *No. 508*

"SEAL IN" DEPENDABILITY *(Cont.)*

stator coils are completely protected against vibration, oxidation, corona, and moisture despite high temperature service. Even after 100 hours at 300 F, for example, leakage resistance of the 5600 rpm motor shown is 500 megohms at 500 volts dc.

Other Facts About 7501 Resin: This solventless, silicone resin has excellent dielectric properties and good thermal conductivity. It will withstand continuous service at 400 F and intermittent exposure up to 500 F. Dow Corning 7501 Resin is ideal for impregnating or encapsulating miniature motors, transformers, electrical and electronic assemblies. *No. 509*

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

"Reactive Silicone Resin Intermediates" recently published in Paint and Varnish Production cites advantages and limitations of copolymerizing silicone intermediates with epoxies or short, medium and long oil alkyds. *No. 510*

Silastic Adhesive S-2200, an easily applied, quick vulcanizing material, effectively bonds silicone rubber to metals or to silicone rubber itself. Tests affirm its marked superiority over previously available adhesives. *No. 511*

"A New Diffusion Pump Fluid" reprinted from VACUUM SYMPOSIUM TRANSACTIONS is a comprehensive report on the properties and advantages of a new diffusion pump fluid recently made commercially available by Dow Corning Corporation. *No. 512*

1958 Guide to Dow Corning Silicones—consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 513*

Antifoam B, the lowest priced silicone foam-killer, has greater stability than any other water dilutable silicone defoamer commercially available. Antifoam B will not separate, oil out, settle or precipitate in most applications; retains uniformity and effectiveness even under adverse storage or operating conditions. Ready to use, it requires no diluting or pre-mixing. *No. 514*

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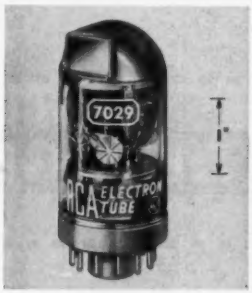


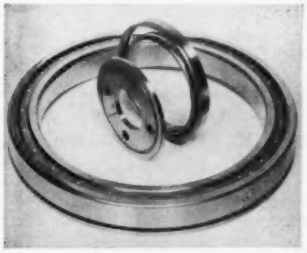
sponse of the ten-stage unit covers a range from about 2900 to 6200 angstroms; maximum response occurs at approximately 4900 angstroms. Maximum overall length is 3.75 in. **Tube Div., Radio Corp. of America**, Harrison, N. J. D

Circle 616 on Page 19

Thin-Section Bearings

used where space and weight must be decreased

Thin-section radial ball bearings are built to specifications for designs where space and/or weight must be decreased. Applications include use in aircraft equipment, portable air tools, magnetic clutches, and portable chain saws. Bearings can be fabricated from almost every bearing material, including magnetic and nonmagnetic stainless steel, SAE 52-100, aluminum,



bronze, K-Monel, and ceramics. Bearings can be either full complement or retainer type. One example has a bore of 30 mm, OD of 42 mm, and width of 7 mm. **Ann Arbor Bearing & Mfg. Co.**, 815 Wildt St., Ann Arbor, Mich. H

Circle 617 on Page 19

Pancake Motor

is 60 per cent shorter than standard-frame units

New pancake motor is for use on machine tools, roof-ventilating fans, and other applications where space

Circle 483 on Page 19→

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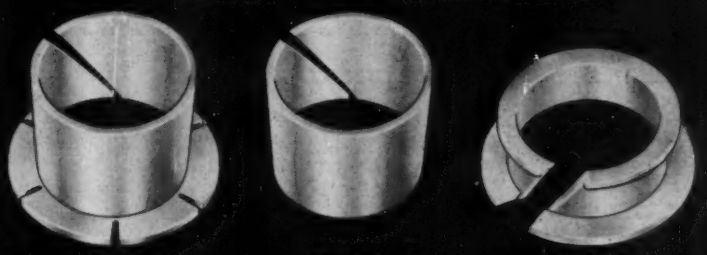

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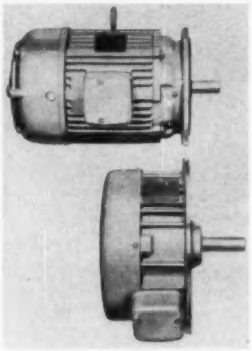
is at a premium. A flange-type motor of radial air-gap design, it achieves short length through use of formed end coils and one-piece housing-bearing bracket. Unit, which is up to 60 per cent shorter than motors of same rating, is available in either open drip-proof or enclosed construction. Ratings



range from 1 to 15 hp at 1800, 1200, and 900 rpm. New motor (bottom) carries the same rating as standard motor (top). **Louis Allis Co.**, Dept. P, 427 E. Stewart St., Milwaukee 1, Wis. K

Circle 618 on Page 19

Fastener

pushes onto unthreaded rods or rivets

New Type W Pushnut fastener pushes onto unthreaded rods or rivets for secure assembly. Made of heavy-gage tempered spring steel, fastener eliminates need for threading, notching, drilling for cotter pins, and other auxiliary operations or parts. Unit applies with quick tap of hammer, without denting or deformation during assembly. Locking design assures in-line application without cocking or misalignment. Removal forces range from 100 to 1000 lb, depending on type and size used. Type W Pushnut is available for 3/16, 3/8, and 7/16

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Circle 484 on Page 19

V

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Circle 485 on Page 19

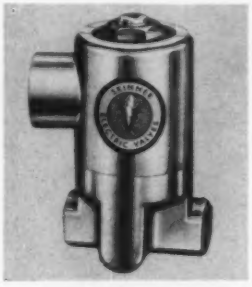
in. diam unthreaded rod. Uses include fastening of wheels on toys, trainer bicycles, and wagons, for bicycle pedals and other similar applications, and for many industrial fastening applications where strong holding power is desired. **Palnut Co. Inc.**, 75 Glen Rd., Mountainside, N. J. D

Circle 619 on Page 19

Solenoid Valve

handles pressures from 5 to 200 psi

New two-way R Series solenoid valve combines large orifice capacity with high pressure differential. It is a normally open or normally closed unit with ¼-in. orifice and ¼ in. NPT, and handles pressures from 5 to 200 psi. Valve can be used with common media, such as air, water, oil, and semicorrosive media, at temperatures from



−65 to 150 F. Options include manual override and wide selection of coils—high-temperature, waterproof, and standard—for common ac and dc voltages. Choice of electrical connections includes single and double automotive terminals, conduits, and grommets. **Dept. R141, Skinner Electric Valve Div., Skinner Chuck Co.**, 105 Edgewood Ave., New Britain, Conn. B

Circle 620 on Page 19

Mechanical Counter

operates at speed of 2000 rpm

Model 7102 Digicon, a mechanical counter with electrical readout, features torque of 0.5 oz-in. and operational speed of 2000 rpm. It provides visual readout counts to 9999.9. Number wheels, with high current-carrying capacity, are lighted for visual and photographic

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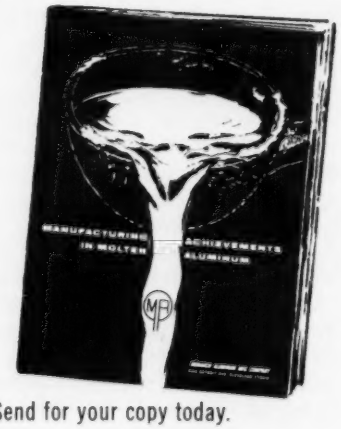

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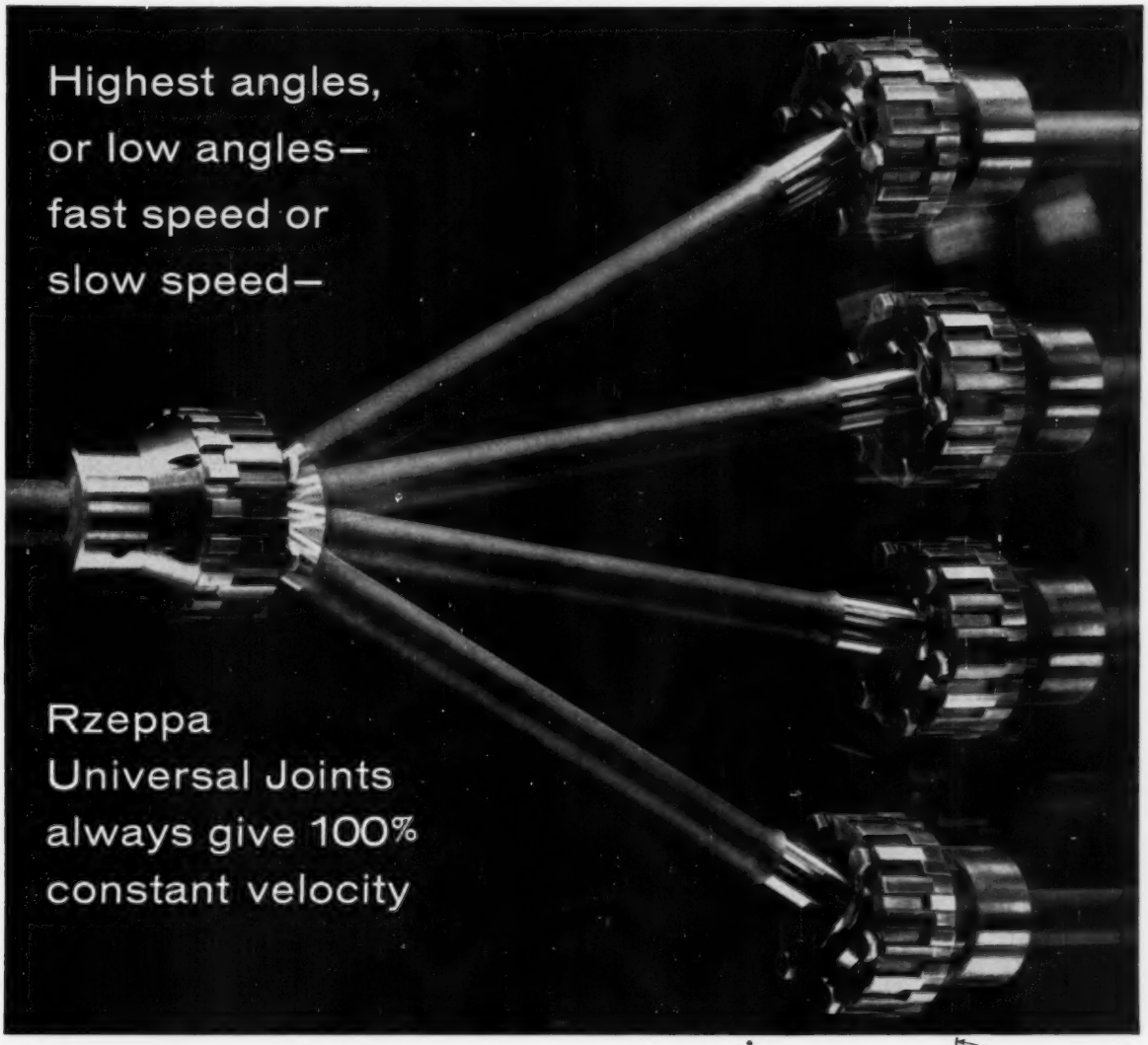

No matter what the application—aircraft, marine, vehicular or industrial, Rzeppa (pronounced "Sheppa") Constant Velocity Universal Joints operate without chatter or bounce, assure longer joint and shaft life through ball-bearing smoothness.

Combining Constant Velocity with higher usable working angles, Rzeppa Joints have the strength and capacity for heavy-duty coupling and drive-line jobs, yet their inbuilt precision provides vibration-free performance in the most critical design applications.

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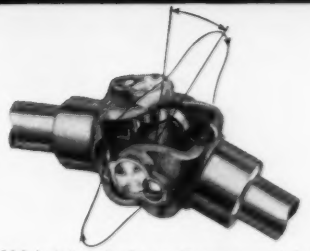
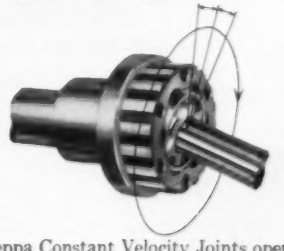


Old-fashioned pin or slipper-type joints speed up and slow down twice during one revolution, must use precision alignment techniques to compensate for "rock and roll" action.



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clarity. Unit measures 1.7 x 1.9 x 1.9 in., operates in temperatures from −40 to 85 C, and withstands acceleration to 10 g. **Digitran Co.**, 45 W. Union St., Pasadena, Calif. L

Circle 621 on Page 19

Sealless Pump

in 1/10 or ¼-hp models

Model 5P-4521 sealless pump has triple discharges which may be used individually, simultaneously, or in any combination. Unit is available in two lengths, and has no seals or metal-to-metal contacts. Pump is satisfactory for handling either clean coolants, or liquids containing grit and abrasives, such as

on grinding, honing, and lapping machines. It is available with 1/10-hp, 1725 or 3450-rpm, or ¼-hp, 3450-rpm motor, for heads to 30 ft and capacities to 30 gpm. **Ruthman Machinery Co.**, 1811 Reading Rd., Cincinnati 2, Ohio. G

Circle 622 on Page 19

Subminiature Switch

for limited-space applications

E4-134 snap-action subminiature switch features small size, dimensional stability, and long mechanical life at 0.005-in. overtravel. Switch is available with turret or standard solder terminals and with a range of actuators for manual, in-

(Advertisement)

APPLYING RELIANCE V★S DRIVES IN CYCLING EQUIPMENT

BY
V. R. MURPHY, E.E.
Manager of V★S Products
Reliance Electric and
Engineering Company

Years of application experience have proved Reliance V★S Drives are ideal for powering cycling equipment. The all electric design is fast acting, acceleration times in tenths and hundreds of a second are common. V★S equipment lends itself to a variety of automatic controls.

V★S DRIVE COMPONENTS

A V★S Drive operates from standard a-c. power lines and consists of three basic components: d-c. drive motor, packaged motor controls and operator's control station.

Reliance drive motors change speed over a wide range, smoothly and without speed steps. The all electric design permits the inclusion of built-in dynamic or regenerative braking, giving fast, maintenance-free stopping power.

Motor-generator sets or electronic rectifiers, working from in plant a-c. power lines, form the nucleus of the motor control unit. A series of built-in controls regulate voltage and current in the system. With these controls, any required combination of speed, horsepower, torque and time characteristics are produced.

CYCLING WITH TENSION CONTROL

An example of simple, rapid cycling is shown in Figure 1. This is the operating cycle of a small winding machine that rewinds wax paper and similar material from large production rolls onto smaller rolls for retail sale. The operation requires a fast winding speed, as well as a slow speed for changing retail rolls. After the new roll is started, the productivity of the machine depends on how fast it can get to winding speed without tearing the material.

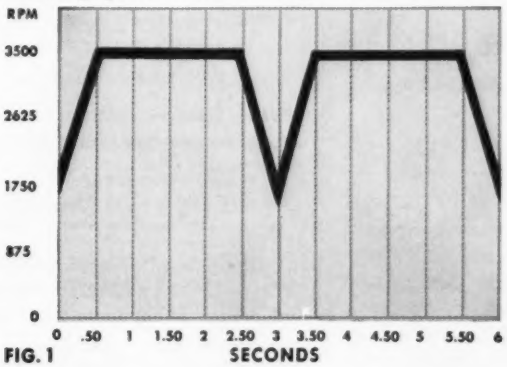

FIG. 1

A Reliance VST Control is used to force motor voltage to give optimum acceleration and deceleration rates. Selected rates can be designed into equipment to meet any cycling requirement. A description of this machine is found in Bulletin D-1532.

FORWARD AND REVERSE CYCLING

Another type of cycling operation is shown in Figure 2. This shows the cycle pattern of a flying cut-off on a continuous pipe mill. A V★S Drive automatically, measures the pipe length, starts the cut-off carriage and brings it to line speed, stops after cut-off and returns the carriage for another cut.

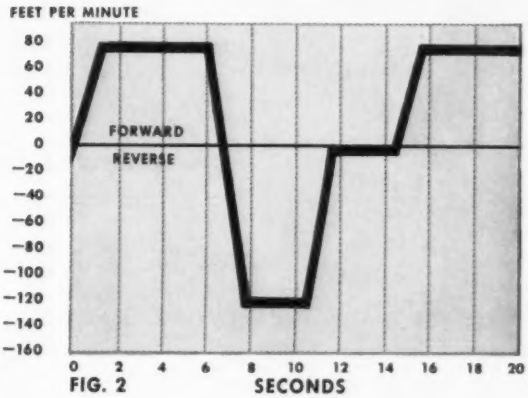

FIG. 2

A digital counter measures the pipe as it passes through the carriage. When the correct length has been fed through, the motor is forced and rapidly accelerated, bringing the carriage up to line speed. Using a dual tachometer matching system and a VSR speed regulator, the carriage speed is exactly matched to line speed during cut-off. After cut-off, the carriage is returned to its starting position, while the counter measures for another cut. A description of this drive is found in Reliance Bulletin L-2505.

These are two of the many types of cycling operations that utilize Reliance V★S Drives. The variety of Reliance V★S Controls, and the wide horsepower and speed ranges, make these drives applicable to any cycling operation. Cycling is only one operation for which the V★S concept is suited.

If you would like further information on how you can use V★S Drives when designing your product, contact your local Reliance representative, or write to the V★S Product Department. D-1581

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Circle 489 on Page 19

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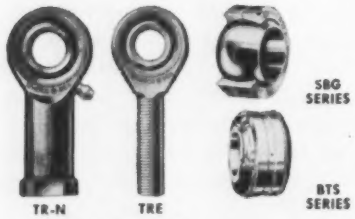

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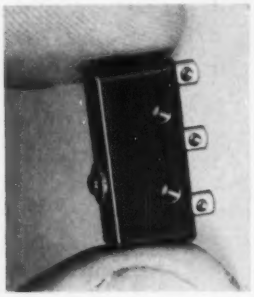
Circle 490 on Page 19

line, cam, or slide applications. Only 25/32 in. long, unit is applicable to business and vending machines, electronics, and other uses requiring precise electrical control in



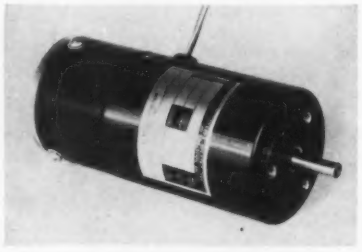
limited space. Ambient temperature range is −65 to 250 F. **Electro-Snap Switch & Mfg. Co.**, 4218 W. Lake St., Chicago 24, Ill. J

Circle 623 on Page 19

Miniature Brakemotor

for actuator applications

Type FC motor with diameter of 1.675 in. is available with new electromagnetic brake providing up to 10 oz-in. holding torque when unenergized. Motor can be furnished as hysteresis synchronous or induction type for 60 or 400-cps operation. Combination of brake and motor is useful for actuator applications because of high torque rating of motor and fast stopping and high



holding torque provided by brake. Overall length of brakemotor is 3¼ in. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio. G

Circle 624 on Page 19

Flow Meter

has snap-in construction

Series 2700 variable-area flow meter features packingless, snap-in metering tubes. O-rings are used to seal tube ends to metal fittings, eliminating nuts, bolts, stuffing boxes, and packing glands. Side frames and

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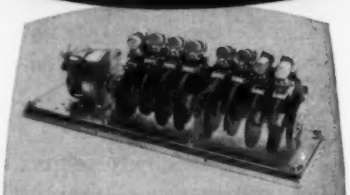

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Staley Programmers are used wherever accurate programming is required. Typical applications for OEM equipment and industrial processing control include:

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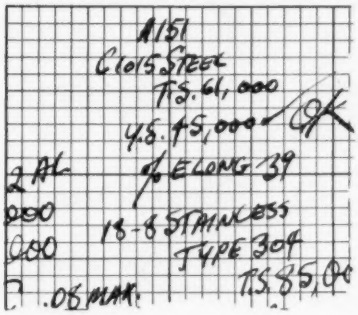
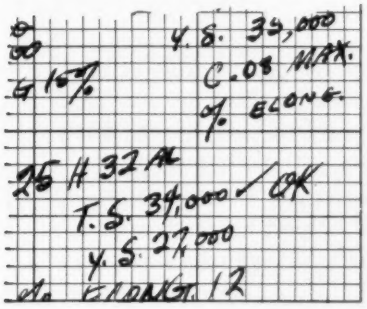
Circle 491 on Page 19

How strength can be designed into component parts

Only the stamping method of production offers such an unrestricted latitude of material selection. With stampings, strength can be designed right into a product or component part. It can be specified into the basic material and improved during the stamping process . . . it can be predicted, controlled and maintained. Strength in stampings can, in fact, be higher in proportion to weight than is possible in any other metalworking process.



All parts, pieces or units are designed around their predetermined end use. The end use pretty much dictates the material to be used in making the component. Only in stampings are the metal, finish and inherent characteristics of the part completely controlled and established beforehand by the design demands. With stampings, there is no need to sacrifice strength to gain other desirable properties. And in stampings, strength is achieved and not just approximated.



Durability is another quality inherent in every stamping. Because stampings are not fragile, they will not break or crack even when thrown out of line or dented by careless handling.

The resilience which characterizes stampings adds to their versatility in production, shipping, finishing and to the manner of their final assembly with other stampings, other component parts, to form a finished product.

Stampings Keep Clutches Rigid

COMMERCIAL close-tolerance stamped housings—ten sizes up to 40 inches in diameter—maintain dimensional accuracy in clutch and brake construction

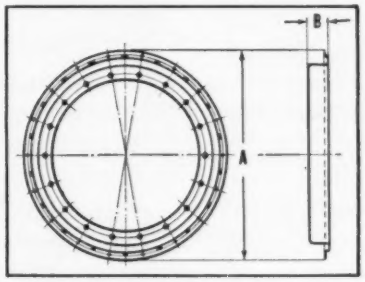
Because the side housings of the Fawick Airflex Type E clutches are stamped to close tolerances, no costly machining is required before assembling.

This unique clutch puts all the load on torque bars which rest on the stamped housings. The clutch design takes full advantage of the inherent strength of the positioned steel.

The Fawick clutch assemblies are used in a wide range of sizes for clutch and brake applications in heavy-duty original equipment. COMMERCIAL has been supplying the stamped housings for the assemblies since 1944 when they first designed and built the original dies.

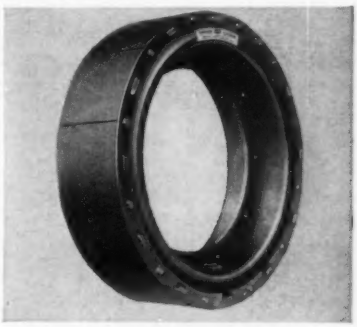
Close tolerances on pierced holes and slots insure perfect alignment of mating parts in final assembly.

Gang piercing provides the required dimensional and location accuracy of holes and slots without the cost of multiple drilling. Slotted openings with integral tabs are formed without metal fracture. The sharp bottom radii and straight sidewalls require a deep draw. Yet, close tolerances must also be maintained on these dimensions.



A	11⅞	13⅞	15⅞	18⅞	21⅜
B	2⅜	2⅜	2⅜	2⅜	2⅜
A	23⅞	26⅞	29⅞	33⅞	39⅞
B	2⅜	2⅜	3 11/32	3 11/32	3 29/32

Typical tolerances in the Fawick stamped housings are +.005" − .000", +.005" −.005", +.000" −.010" Special notes on shop drawings call for all holes equally spaced, within tolerances of plus or minus .005" while parallel surfaces are maintained. COMMERCIAL'S ability to meet such stiff stamping requirements reflects its skill and experience in handling unusual metal forming problems.



Fawick's non-mechanical drum-type clutch requires the accuracy of COMMERCIAL stamped housings when continuous pressure is applied.

These clutches in use on power shovels, locomotive cranes and other heavy-duty equipment, keep the load from slipping through friction The housings stamped by COMMERCIAL withstand the load and the heat generated by the friction involved, yet maintain the alignment and accurate dimensions to which they are stamped.

If you have a design problem involving component parts, we may be able to suggest a practical and economical solution based on our 30 years experience in forming metals. Send details of your problem to Commercial Shearing & Stamping Company, Dept. S-18, Youngstown 1, Ohio.

COMMERCIAL
shearing and stamping

Circle 492 on Page 19

YESTERDAY it wasn't there. Today, he picks it up and wonders: *why did it grow like that?* The miracle of growth! Whether it's a "toadstool" that springs up overnight or a cancer cell that suddenly comes into being, we've a lot to learn about the whole beautiful process of orderly growth . . . and the dreadful, senseless growth that is cancer.

The cancer puzzle is tied up in growth —growth of body cells smaller than the periods on this page.

Scientists, working under grants from the American Cancer Society, are ceaselessly studying cells—normal and cancer cells. And they too are asking: *Why?*

Why do cells suddenly change from normal growth to uncontrolled, disorderly growth? This question can be answered only by the most probing, painstaking and costly research.

Your contributions to the American Cancer Society will support hundreds of scientific studies necessary to save lives today and tomorrow.

Remember: Cancer can strike anyone. But you can strike back *hard* with your dollars. Send your gift to CANCER in care of your local post office.

AMERICAN CANCER SOCIETY

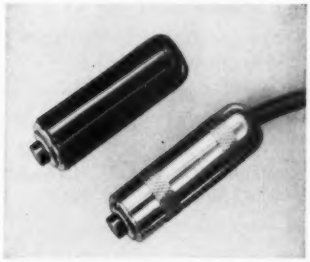
front and rear covers are also of snap-in construction. Design permits coverage of flow ranges from a fraction of a cc per min to 40 gpm with only three metering sizes. **Fischer & Porter Co.**, 577 Jacksonville Rd., Hatboro, Pa. E

Circle 625 on Page 19

Pushbutton Switch

is cord-mounted or pendant unit

Small pushbutton switch, enclosed in a handle, can be used as a cord-mounted or pendant switch, or as a remote-control switch for turning off microphones and pilot lights. It has nickel-plated brass or black phenolic housing, red or black push-



buttons, and is nonlocking. Unit is rated at 250 mils, noninductive, 30 w ac max. **Switchcraft Inc.**, 1328 N. Halsted St., Chicago 22, Ill. I

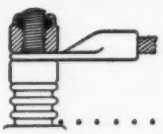
Circle 626 on Page 19

Flow-Control Valve

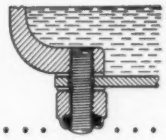
for 2000-psi service

Multirange hydraulic flow-control valve is unaffected by changes in temperature and viscosity. Designed in $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{3}{4}$-in. sizes, it is available for 2000-psi service. Valve consists of two basic elements—fluid-pressure compensator and variable orifice. Compensator element maintains a constant pressure drop

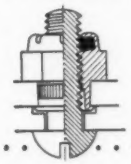
Elastic Stop nuts solve these 6 design problems



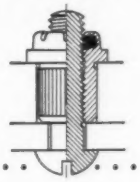
COUNTERACT LOOSENING EFFECTS OF VIBRATION and impact on electrical terminals during transit or operation—the Elastic Stop nut will not loosen and thus assures positive contact, even under severe shocks, for electrical and electronic assemblies.



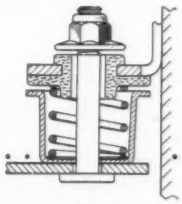
SEAL BOLT THREADS against liquid leakage (external or internal). The nylon locking collar conforms to the bolt thread with a perfect fit that prevents seepage past the nut.



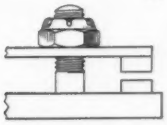
BLIND FASTENING APPLICATIONS—are simplified by clinch type nut which is swaged into sheet metal, becoming self-retaining as well as self-locking.



DRILLING AND TAPPING OF SOFT METAL CASTINGS are eliminated by the spline type nut which provides steel thread strength for soft metals and can be easily pressed into bored hole in casting.



SPRING MOUNTING AND PRECISE ADJUSTMENT is provided by special flange type nut which can be adjusted easily and will remain "stopped" at any point on the bolt. (Flanged face eliminates need for extra washers.)



MAINTAINS PRECISE CONTACT GAPS on make-or-break adjustment studs where long-term accuracy is important. (Note "thin" height design for limited clearance.)

HERE'S HOW IT'S DONE—The red locking collar of the ELASTIC STOP® nut grips bolt threads with a perfect fit that will not loosen under severe vibration or stress reversals. By bringing nut and bolt metal thread flanks into firm contact it eliminates wear producing axial play. The elastic locking action of the insert-type stop nut does not distort or gall bolt threads. It is reusable many times.

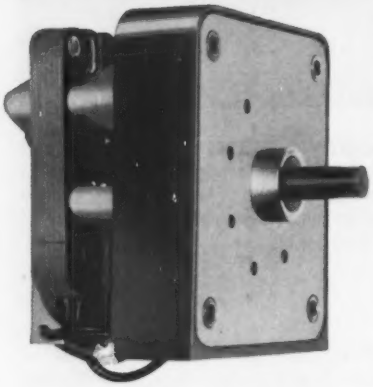
Send for the complete Elastic Stop nut bulletin. Or enclose a drawing of your product for specific self-locking fastener recommendations. There's no cost or obligation. Write Dept. S16-54, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Circle 493 on Page 19

put HEINZE in your designs



NEW
HEINZE
GEARMOTORS
with
choice of
Drives–
Speeds

Powerful, compact, quiet . . . Heinze Gearmotors offer four sub-fractional horsepower driving motors: 2 and 4 pole induction; universal; reversing. Speeds range from approximately 700 rpm down to 1 revolution in eight minutes. Geartrain may be enclosed or open, base or panel mounted. Gears, pinions and shafts are made from finely tempered and hardened steel. Felt oil reservoir in geartrain guards against oil leakage. Oil-impregnated bronze bearings insure long, trouble-free operation.

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HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.
Sub-Fractional Horsepower Motors and Blowers

HEINZE ELECTRIC COMPANY, Dep't D
685 Lawrence Street, Lowell, Mass.

Please send me literature and prices on Heinze Gearmotors.

Name & Title.....

Company.....

Street & No.....

City & State.....

Circle 494 on Page 19

across variable metering orifice. Pressure drop is maintained regardless of differential pressure across valve. Flow through orifice is unaffected by changes in temperature or viscosity, permitting constant, accurately controlled rate of flow. Minimum and maximum flow con-

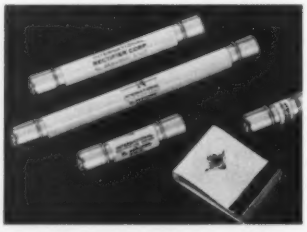
trol range varies with valve size, from 5 cu in. to 5 gpm for ¼-in. port size to 5 to 28 gpm for ¾-in. port size. **Denison Engineering Div., American Brake Shoe Co.**, 1160 Dublin Rd., Columbus 16, Ohio. G

Circle 627 on Page 19

Miniature Rectifiers

mount in standard 30-amp fuse clips

Series of hermetically sealed, high-current silicon cartridge-type rectifiers for forced-air or liquid cooling utilize metallized ceramic housings with ferrule-type terminals for mounting in standard 30-amp fuse clips. The miniature units are available in peak inverse voltage ratings from 1500 to 16,000 v at rectified dc output from 210 to 360 ma. Rectifiers are particularly suited to airborne power supplies because of small size. Other applications in-

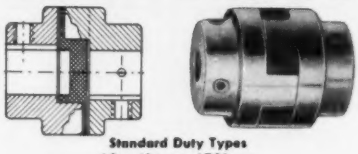


clude dc overpotential testing of insulation in capacitors, transformers, cables, damping out oscillation in electric welding circuits, and as power supplies for electrostatic precipitators. **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif. L

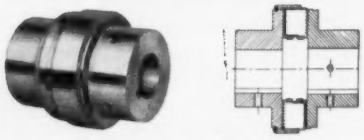
Circle 628 on Page 19

Lovejoy

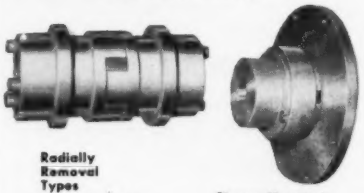
Maintenance-Free
FLEXIBLE COUPLINGS



Standard Duty Types
.05 to 40 hp. at 1750 rpm



Medium and Heavy Duty Types
2.6 to 810 hp. at 100 rpm.



Radially Removal Types
1.9 to 30 hp. at 100 rpm.—2 to 40 hp. at 1800 rpm.

Flange-Mounted Types
11 to 740 hp. at 900 rpm.

Put Trouble-Free Performance Into Your Equipment

COMPARE THESE FEATURES:

- A type and size perfectly suited to your application.
- Year-after-year dependability, regardless of load or operating conditions.
- Completely machined for ease and speed of alignment.
- No lubrication required.
- Simple, rugged construction—few parts and no intricate mechanisms.
- Cushioned power transmission—load is transmitted through cushioning materials—no wear on the metal jaws.
- Double-life cushions—one half the cushions act as idlers, except on reversing loads—quick interchange provides a new set of cushions.
- Cushions are engineered to the load and service conditions.

Ask Lovejoy to recommend the exact flexible coupling for your application. No obligation. Request catalog.

LOVEJOY FLEXIBLE COUPLING CO.
4818 WEST LAKE STREET • CHICAGO 44, ILLINOIS

Circle 495 on Page 19

Tough specifications? You bet.

That's why Maginniss Power Tool Company, leading producer of concrete vibrators, brought its tubing problems to Ohio Seamless. Our engineers recommended Ostuco NP-3 C1040 tubing for Hi-lectric Concrete Vibrator housings.

Here's what Maginniss says after using Ostuco NP-3 Tubing exclusively for 11 years, "*. . . only Ostuco NP-3 Tubing meets our requirements for abrasion resistance and easy machinability. Its fine grain structure cuts clean every time. Furthermore, we have never had a thread failure in the field traceable to tubing quality.*"

Every product, including yours, has materials or production process problems that are uniquely its own. If they involve tubing, Ohio Seamless has the answer. Just contact our nearest sales office, or the plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.* AA-7477

SALES OFFICES: Birmingham • Charlotte • Chicago (Oak Park) • Cleveland Dayton • Denver • Detroit (Ferndale) • Houston • Los Angeles (Lynwood) Moline • New York • North Kansas City • Philadelphia (Wynnewood) • Pittsburgh Richmond • Rochester • St. Louis • St. Paul • St. Petersburg • Salt Lake City Seattle • Tulsa • Wichita

CANADA: Railway & Power Engr. Corp., Ltd.

EXPORT: Copperweld Steel International Company
225 Broadway
New York 7, New York

FIFTY YEARS
OSTUCO SHELBY OHIO
OSTUCO TUBING
1908 1958

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

BEFORE...
Appliance manufacturer installed leg leveling bolt; used square head fastener in crating.
AFTER...
Circle B leg leveling bolt designed with Phillips head, at no extra cost, now does both jobs.

save dollars

with this sense-making idea

LITERALLY thousands of dollars can be saved through the practical application of basic bolt making principles in designing and specifying fasteners.

In the actual case shown, savings were pyramided through reduced inventory, handling, purchasing and production time; while one part was eliminated entirely.

To make this basic information available, Buffalo Bolt Company has drawn on over 100 years of experience to put together a digest of these principles.

You'll find them in our new booklet, "How to specify fasteners . . . and save". Filled with drawings and charts, it makes a handy guide in designing or buying any headed parts.

If you can use a copy, write to North Tonawanda or ask a Field Representative.

BUFFALO BOLT COMPANY

Division of Buffalo-Eclipse Corporation

North Tonawanda, N. Y. • Princeton, Illinois

MAKING BOTH FASTENERS AND FRIENDS FOR 100 YEARS

● *3 convenient service centers*

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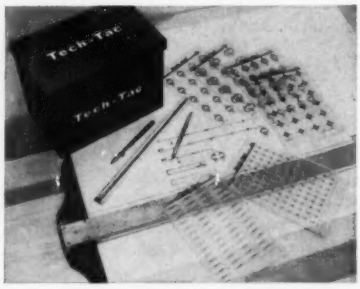
ENGINEERING DEPARTMENT
EQUIPMENT

Drafting Aid

for use in the electronics industry

Tech-Tac is a drafting aid in which symbols preprinted on clear acetate are affixed to drawings by pressure-sensitive dry adhesives. Electronic symbology available covers about 95 per cent of symbol needs in any electronic system. Symbols do not become loose or lose transparency. Drawings can be subjected without damage to heat or chemicals encountered in reproduction methods, and can be rolled for storage. Surface of acetate symbols is matte finish, which will take pencil, ink, and



erasure without damage. Sheets are printed 6 x 9 in., each sheet containing a single symbol duplicated about 48 times. System consists of 165 sheets covering 635 electron tube types, plus transistor, coil, resistor, capacitor, switch, and other symbols in several variations. **Tech-Tac Inc.**, 727 W. Seventh St., Los Angeles 17, Calif. L

Circle 629 on Page 19

Servo Kit

contains 262 breadboard parts

Servo kit BP-101 contains 262 standard parts for high-precision servo-system breadboarding. Included are two grid plates, grid-plate hardware (including bumpers, standoffs, capscrews, and collars), component and shaft hangers, adapters, electric limit stops, se-

TIMERS...SPECIAL DELIVERY

Standard or special— Industrial Timer makes rapid deliveries on all models

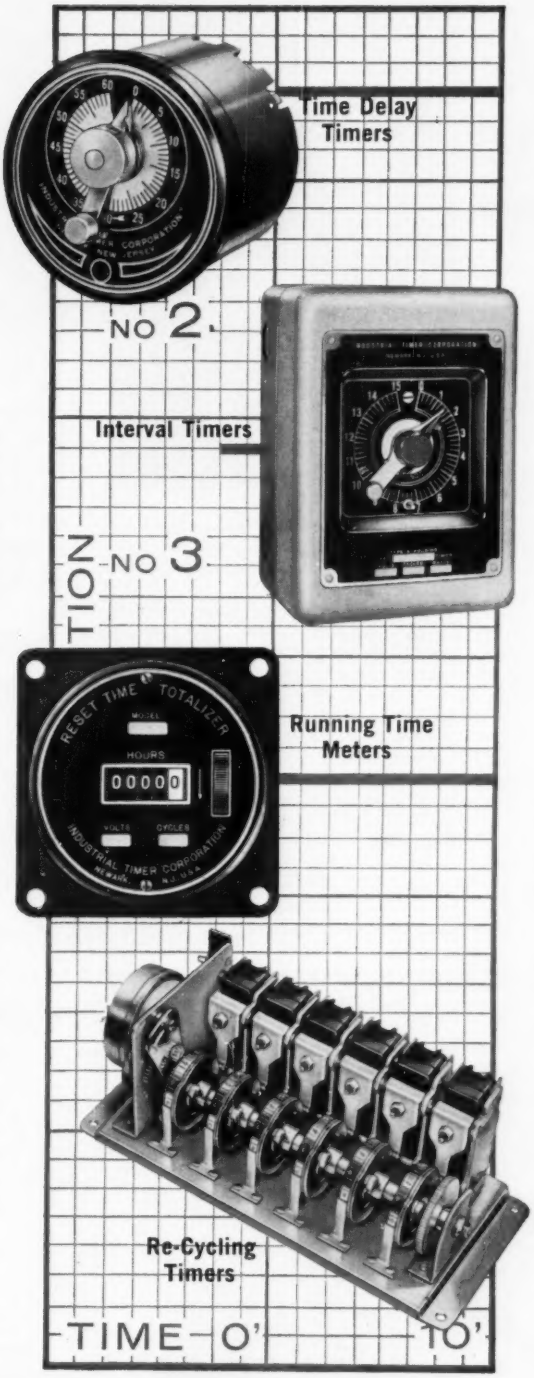
Sometimes you need a standard model timer . . . other times you need a special. Either way we can give you the extra rapid service you may need because of the efficient way we design, manufacture and stock timers for industrial applications.

To meet *all* of the widely varying needs of our customers we manufacture a complete line of timers in the four broad classifications illustrated here:

1. TIME DELAY TIMERS
2. INTERVAL TIMERS
3. RE-CYCLING TIMERS
4. RUNNING TIME METERS

From these we have already developed 20 basic types which can be combined in endless number of ways . . . to date, our engineers have combined them into over 1000 different models. So what might seem to be a special timer requirement to you, will very often be a standard timer in our large stock, and that is the reason we have the ability to fill special orders so quickly. And as far as standard timers are concerned we can give overnight service if necessary.

So, for the utmost in all-round service depend on us for this outstanding combination: deliveries "Immediate on Standards . . . First on Specials".



Speed up your automatic control projects— profit by our timing application experience

No need to let timing problems delay you in your automatic control projects when you can place them with us and get faster solutions. Even though no two automatic control jobs are ever exactly alike, and even though the timer requirements of each are very different we have established an excellent record in helping out in these situations.

20 years of experience in analyzing complex timer applications has provided us with the special knowledge required to give our customers the right answer in near-record time.

Our large stock of standard and combination timers enables us very often to fill orders for these requirements without any time loss because we have already developed so many new combinations specifically for automatic control functions.

Extra special automatic control timer — this calls for original designing. Our engineers will go right to work and get the job done. That's the way we grow and we like it.

Whatever your control problem, you have everything to gain by submitting it to our timer specialists. They'll come up with the answer — almost with the speed of automatic control itself.

AFFILIATE—LINE ELECTRIC COMPANY

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1413 McCARTER HIGHWAY, NEWARK 4, N. J.

This National Torque Converter helps the earth mover to give the job "Everything it's got!"

For 15 hours every working day this 7-yard drag line, owned by Genet & Huffstuttler Company, strips overburden in the Beach Creek area, near Greenville, Kentucky.

A schedule like this is mighty tough on both men and equipment; but the punishment is lightened by the National Torque Converter, that absorbs and cushions every shock that takes its toll in operator fatigue, or shortened equipment life.

The National Torque Converter makes another very important contribution, too. It *takes in* power with the engine working in its most efficient speed and output range. It *delivers* the power at speeds and torques best suited to each specific operation.

In direct-drive machines, the pull available on the bucket depends on the torque capacity of the engine, with a possible "boost" from inertia. If a bucket encounters a heavy load, the pull increases up to the engine's torque capacity . . . but once this point is reached, either the operator eases off, or the engine stalls!

With a torque converter on the same load, the pull increases steadily, up to two or three times the torque available from the unaided engine. The pull is smooth as velvet . . . as though it were delivered by a giant elastic band. The engine cannot stall, and line breakage and boom overload are virtually eliminated.

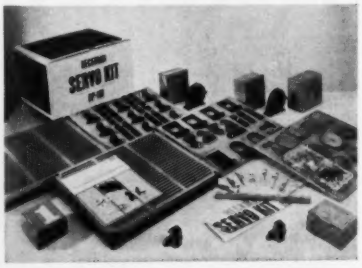
National Torque Converters are available as standard equipment on practically all of the leading shovels and drag-lines, and "packaged" with the engine of 16 builders. The range of sizes and types takes care of inputs from 100 to 1000 hp, under a great variety of working conditions. For further information just write:

THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center

Pittsburgh 22, Pennsylvania



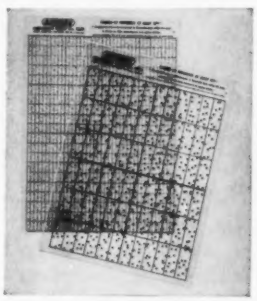
lected precision Class 2 gears, couplings, hand crank, dial assemblies, terminal blocks and brackets, various lengths of shafting, a differential, and mounting screws and washers. Kit contains a checklist which identifies each part and shows where to find it, and a catalog containing photographs, dimensional drawings, and set-up instructions. **Helipot Corp., Div., Beckman Instruments Inc.,** Newport Beach, Calif. L

Circle 630 on Page 19

Measuring Device

performs same functions as a planimeter

Areagraph is an inexpensive method for quick, accurate measurement of irregularly shaped areas on maps, drawings, charts, photographs, and plane objects. Transparent film printed with a pattern of grids and dots is placed over the area to be measured. Dots falling within area to be measured are counted and divided by a simple factor printed on overlay. Answer is given in square



inches. Device is available in sets of three, one chart for each of three predetermined degrees of accuracy—85, 90, and 97 per cent. Overlays are of Mylar polyester film, and grid lines and dots are protected by wear-resistant varnish. **Charles Bruning Co.,** 1800 W. Central Rd., Mt. Prospect, Ill. J

Circle 631 on Page 19

Series 101A
150 psi Air
1500 psi Hydraulic
Meet JIC Standards
Fit where
others won't!

O-M Cylinders give power new dimensions in close quarters

Compared with cylinders of conventional design, having the same size bore, and activated by the same operating pressure, O-M's original Internal Key-type Cylinders develop more power in ⅓ less space on both air and hydraulic circuits.

These compact, powerful components, that fit where others won't, are ruggedly constructed to stand up under protracted service within a wide range of operating pressures. The O-M Internal Locking Key simplifies disassembly, inspection, and service with no alignment problems in reassembly. Besides, the ports can be oriented to any position.

The unique O-M design also assures maximum versatility. By using a majority of standard parts, you get the advantage of "special" cylinders designed to do your job better at a very nominal cost over standard cylinders. These and other engineering advantages and economies of O-M Internal Key-type Cylinders suggest uses in a wide variety of original equipment.

O-M Internal Key-type Air and Hydraulic Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

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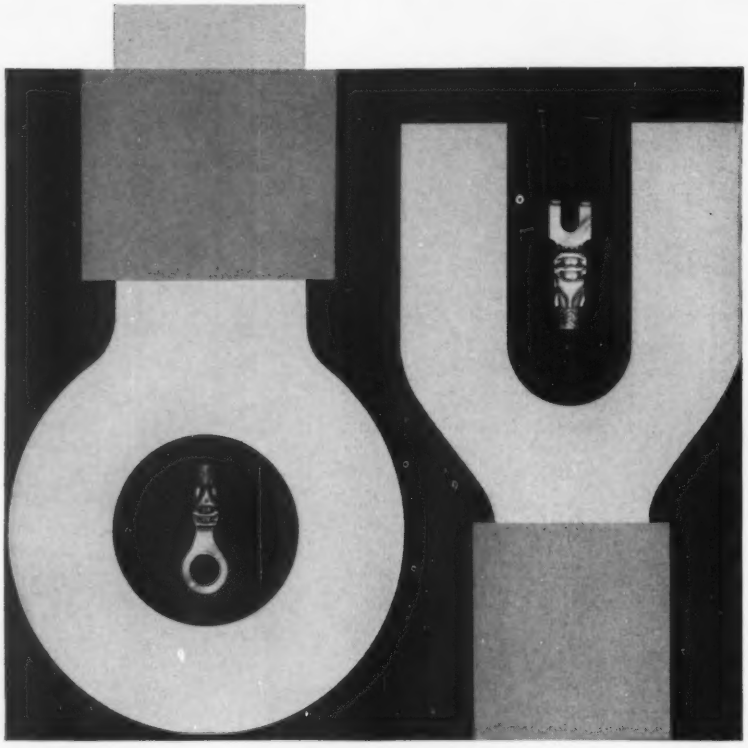
Circle 500 on Page 19



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THE ENGINEER'S Library

Recent Books

Epoxy Resins. *By Henry Lee and Kris Neville; 305 pages, 6 by 9 in., clothbound; published by McGraw-Hill Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.00 per copy postpaid.*

Although this book delves chiefly into the chemistry and preparation of epoxy resins, there is material presented on their use as adhesives, laminates, and coatings.

Discussed also are the physical properties of epoxies which make them suitable for casting, potting, encapsulation, sealing, and lightweight foams.

Inventor's Handbook. *Prepared by Ernest Zadig, Harry Kursh, and Joseph Kraus; 144 pages, 6¾ by 10 in., clothbound; published by and available from Arco Publishing Company, Inc., 480 Lexington Ave., New York 17, N. Y.; $2.00 per copy.*

This handbook is prepared as a guide for both the experienced and novice inventor. Material covers the creation of successful inventions, patent protection, methods of avoiding court action on patents, protection of trademarks and slogans, and markets for inventions. A feature section includes discussion on 11 general fields of invention.

Association Publications

Standardization Economy through Application. *128 pages, 8½ by 11 in., paperbound; published by and available from Standard Engineers Society, P. O. Box 281, Camden 1, N. J.; $3.75 per copy.*

Contained in this publication are 18 papers presented at the Sixth Annual National Meeting. In addition to cost reduction and reliability, subjects covered include technique and preparation of standards, sources of information for preparation of standards, making standards information available, and co-opera-

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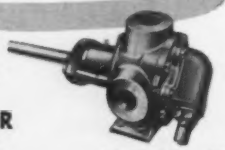

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See Our Catalog in Sweet's Product Design File

Circle 503 on Page 19

tive efforts between standards and other departments.

Standards, Key to Progress and Profits. *158 pages, 8½ by 11 in., paperbound; published by and available from American Standards Association Inc., 70 East 45th St., New York 17, N. Y.; $4.00 per copy.*

This group of 44 papers, presented at the Eighth National Conference on Standards, presents the role standards play in simplifying procedures and cutting costs in areas of purchasing, design, and engineering.

Proceedings of the 1956 Regional Conference on Reactive Metals. *180 pages, 8½ by 11 in., paperbound; published by and available from American Institute of Mining, Metallurgical, and Petroleum Engineers Inc., 29 West 39th St., New York 18, N. Y.; $5.00 per copy to members, nonmembers, $7.50 per copy.*

This group of 22 papers includes information on fabrication, application, and general metallurgy of reactive metals, including titanium.

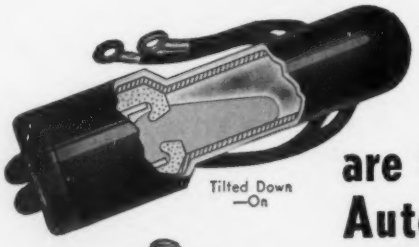
Middle Atlantic Conference Transactions, 1958. *275 pages, 5½ by 8½ in., paperbound; published by American Society for Quality Control, and available from Mr. F. Bruce May, Revlon Inc., Route 27 and Talmadge Road, Edison, N. J.; $2.50 per copy.*

This publication contains 30 papers on quality control delivered at the 1958 Middle Atlantic Conference. Various aspects of quality control are covered, such as applications in industry, management, programming, testing, and training.

Government Publications

Status of High Strength Steels for the Aircraft Industry, PB 121639. *By R. J. Nekervis, C. H. Lund, and A. M. Hall; 88 pages, 8½ by 11 in., paperbound; published by and available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $2.75 per copy.*

This report describes and discusses six high strength steels which have been found suitable for possible application in the aircraft industry. Some discussion is presented on their utilization in the non-airframe industries.



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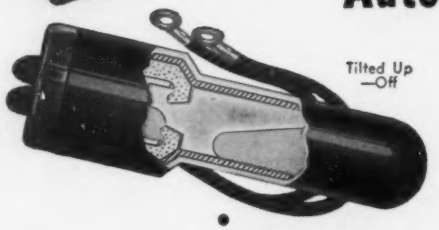

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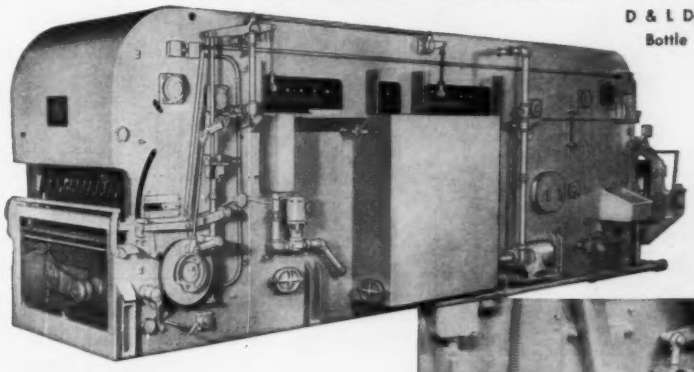
Circle 504 on Page 19

Heim *Unibal* Rod Ends

compact . . . easily adjusted . . . bind-free

The Dostal & Lowey Company manufactures automatic bottle washing machines. There is a Single End machine of rugged construction which can be operated by unskilled labor; and there is a Double End washer of great speed and efficiency for high production.

The D & L Single End machine uses 28 and the Double End machine uses 14



D & L Double End Bottle Washer

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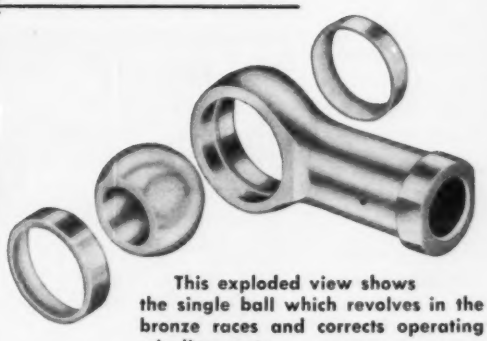
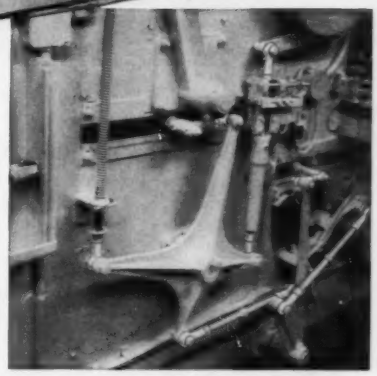


This exploded view shows the single ball which revolves in the bronze races and corrects operating misalignments.



D & L Single End Bottle Washer

Have *You* considered the versatile Unibal for your linkages? Heim engineers will help you with suggestions and samples. The leading bearing distributors carry Heim Unibal.

Unibal has many advantages, but those features which led D & L to choose Heim Rod Ends were their compactness, their ease of adjustment after installation, and the fact that they operate with a bind-free smoothness. The minimum maintenance (not a single failure or replacement in six years of use) and self-alignment of Unibal further improves the smooth operation of the D & L Bottle Washers.

The use of Heim Rod Ends in practically all motions of the machines has helped to bring out an important sales point — spare parts inventory is kept to a minimum.

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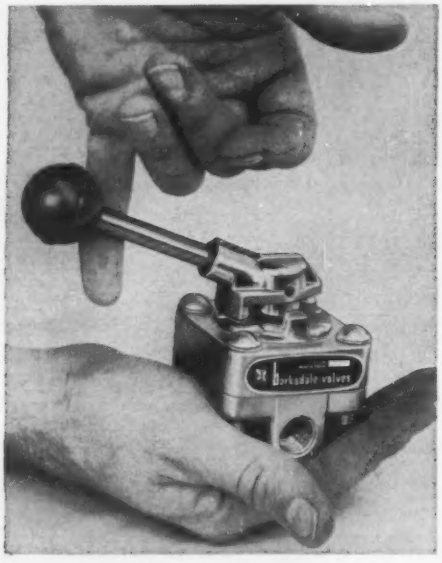
THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Circle 505 on Page 19

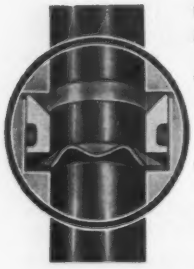
NEW VALVE FOR THE ORIGINAL EQUIPMENT MARKET

250 P. S. I. four-way air valves in ¼, ⅜ and ½ inch pipe sizes.



This is a re-design of our proven 250 P. S. I. air valve.

NEW LOW PRICE (*the result*) FACE LIFT (*the reason*)



None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!

. . . same non-corrosive construction throughout — eliminates failures due to rust.

. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced.

Write for bulletin 5000 which includes design specs.

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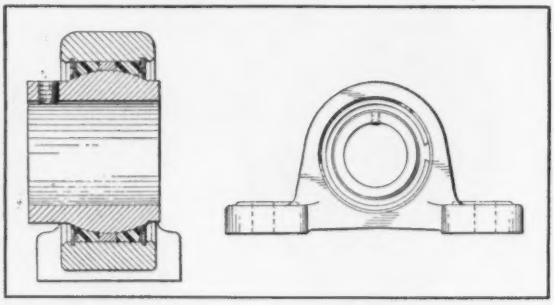
NOTEWORTHY Patents

Combination Bearing

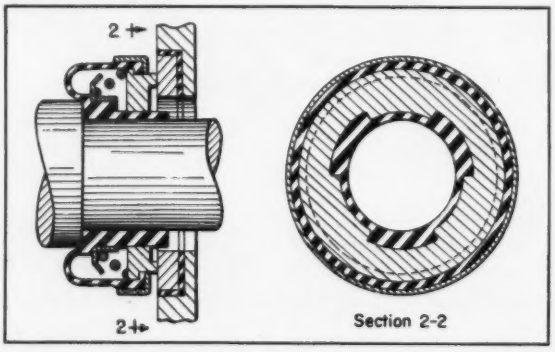
Both radial and thrust loads are supported by a low-cost combination bearing with a self-lubricating feature. Interposed between inner and outer races,



nylon load-bearing rings mate with the spherically contoured inner race. Lubricant reservoir is an impregnated fibrous ring separating the nylon members. *Patent* 2,814,538 *assigned to O. and S. Bearing and Mfg. Co., Detroit, Mich., by John E. Connolly.*

Mechanical Seal

Protection for the face-loading spring in a mechanical-seal assembly is provided by a one-piece elastomer enclosure. Resiliently keyed to the rotating



seal ring, the enclosure also forms a static seal to block leakage of fluid between the rotating ring and the shaft. Unit is designed for packaged assembly. *Patent* 2,806,720 *assigned to Muskegon Piston Ring Co., Muskegon, Mich., by Walter W. Meyer.*

Constant-Flow Valve

Compensation for inlet-pressure variation is automatic in a solenoid-type valve designed to meter fluids at a substantially constant flow rate. Compensating feature is provided by flexure of an elastic valve-seat

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Circle 507 on Page 19

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LEPEL Electronic Tube GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.

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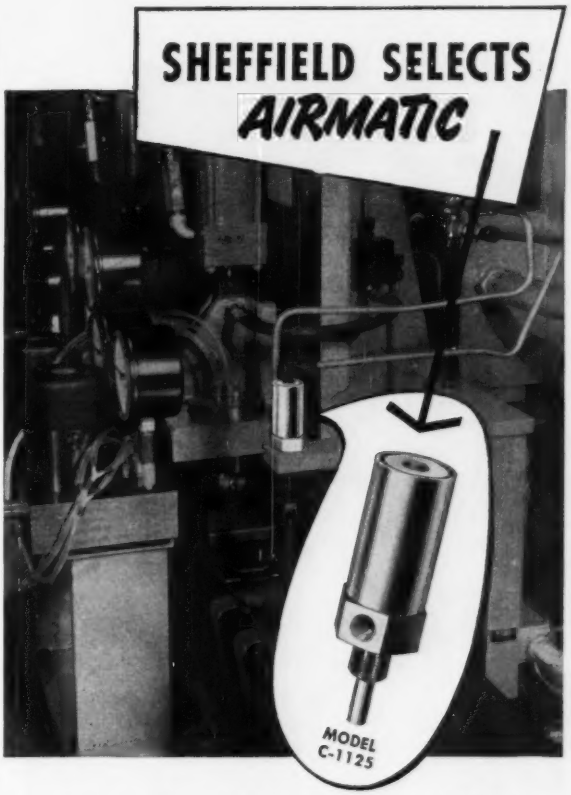
SHEFFIELD SELECTS AIRMATIC



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SOLUTION: The Model C-1125 1⅛" small-bore cylinder shown above.

Airmatic cylinders are machined from brass tubing and bar stock. No castings are used. The front head is threaded to the cylinder tube. "O" rings of the aircraft type mean smooth trouble-free operation with long life between servicing of the packing. They are available in sizes of ⅜", ½", ¾", 1", 1⅛" and 1½" with single threaded end or clevis end.

OTHER APPLICATIONS: Airmatic small-bore cylinders are especially useful in test jigs, miniature air vises and in automatic work for feeding, ejecting, soldering, welding, brazing, stamping and bending as well as marking.

OTHER MODELS: Airmatic makes over 300 models of valves and cylinders for almost every mechanical control need. For complete details, write or telephone Cleveland: WOodbine 1-8633.

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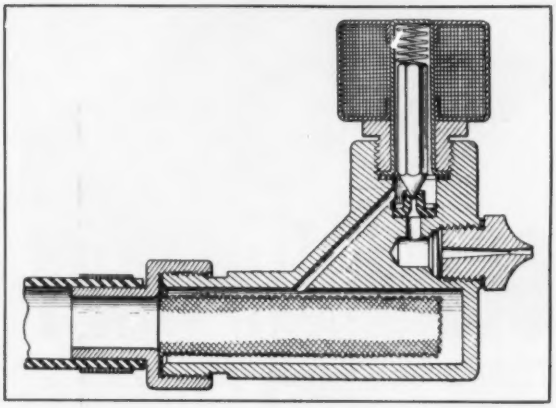
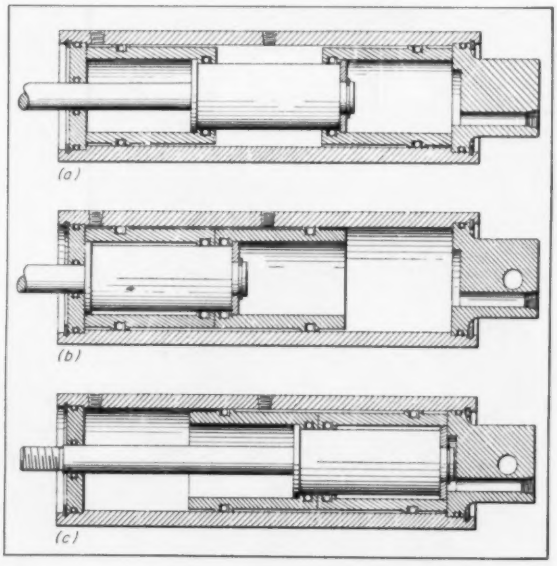


member. Shaped as a venturi, the seat closes down to restrict flow when inlet pressure is high and opens up when inlet pressure is low. Unit illustrated holds flow rate to ±10 per cent of rated value (0.4 gpm) over an inlet pressure range from 25 to 150 psi. *Patent* 2,815,923 *assigned to General Electric Co. by Kendall Clark, Glen Ellyn, Ill.*

Three-Position Fluid Actuator

Conventional four-way valve controls movement of the piston rod in a three-position actuator. Principal components of the actuator are: 1. Cylinder, capped at one end and containing a rod gland at the other. 2. Piston and rod assembly. 3. Two opposed tubular



pistons. Cycle of operation is shown here with the piston rod in three positions: *a*, intermediate; *b*, fully extended; *c*, fully retracted. Position at either extreme is obtained when one end port is pressurized, the other end port vented to drain, and the center port blocked. Intermediate position of the piston and rod is obtained by pressurizing the center port and venting both end ports to drain. *Patent* 2,806,449 *assigned to Harris Foundry and Machine Co., Cordele, Ga., by John R. Simmons.*

Circle 510 on Page 19

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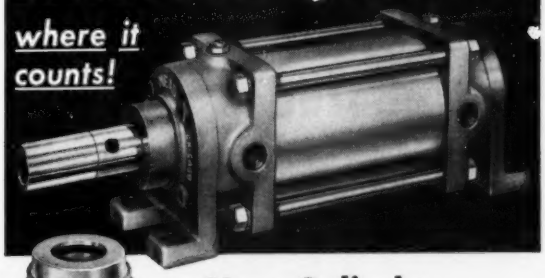

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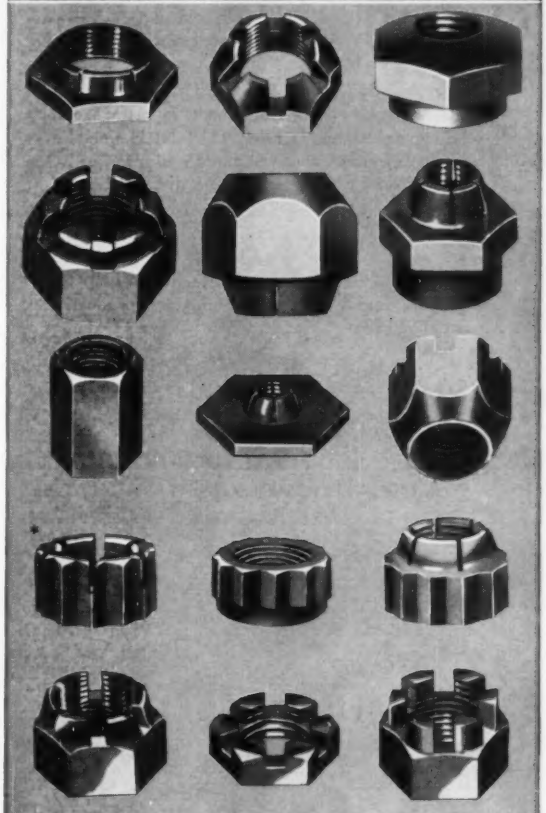

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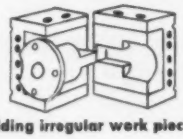

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Only Eastman can give you the above Split Flange with the advantages of Eastman's exclusive "Inter-Lock" Clamp:

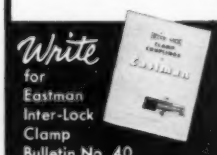
1 **"Inter-Lock" Clamp for Best Hose Connection** — Accurate machining assures alternate positioning of ribs of clamp and barbs of insert—**avoids pinching and weakening of hose**—creating exclusive Eastman Inter-Lock grip.

2 **Split Flange for Tighter Seal at High Pressures**—Cuts production and replacement costs with a No-Thread, No-Leak "O" Ring Connection which eliminates threads, sealing compounds, spiral leaks and housing distortion.

Rely on Eastman for quality—first to be specified by America's leading OEM's.

Permanently Attached Flanged Head Couplings:
¼" thru 2"
375 to 5000 p.s.i.

Clamp Type Coupling with Split Flange Stems:
¼" thru 2"
375 to 5000 p.s.i.



Write for Eastman Inter-Lock Clamp Bulletin No. 40.

Eastman
MANUFACTURING COMPANY
Dept. MD-5A, Manitowoc, Wisconsin

Circle 515 on Page 19

Design Guide to

"Adjustable-Speed Drives"

- **ELECTRICAL**
- **MECHANICAL**
- **HYDRAULIC**

Here, in one book—148 pages, with 24 tables, 119 charts and 171 illustrations—is what the designer should know about adjustable speed.

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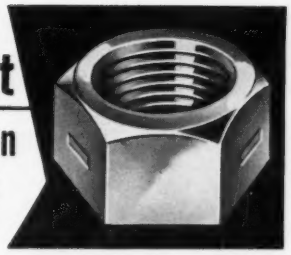
NEW Centerlock Nut

saves production time... speeds application



Here is a new low cost lock nut that can be applied from either end, double chamfered, with the locking feature in the center. The greater speed in application of these Centerlock Nuts can make definite savings in production time and provide low cost fastening. Ideal for customer assembled products.

The New Centerlock...

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Write for samples and NEW CATALOG today

GRIP NUT COMPANY

103 Maple Ave. South Whitley, Indiana

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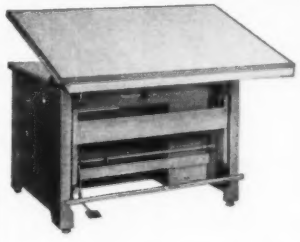

A Drafting Table Featuring an All Steel Top

Mayline introduces an all steel top covered with Jaspe green linoleum, with a drawing surface of the proper resilience. Reference top also covered with linoleum.

The new May-O-Matic table has a height adjustment mechanism insuring smooth, positive operation. Also has an adjustment to counterbalance weight added by lights, drafting machines, and straightedges. This new table is described in Folder S-22. Send for your copy today.

MAYLINE COMPANY

601 No. Commerce St.

Sheboygan, Wisconsin

MAYLINE MAYLINE

MAYLINE

Circle 518 on Page 19

HUSCO

Doubles Production Capacity to Increase Availability of its Hydraulic Valves, Cylinders and Special Controls

Large new Husco plant addition, more than doubling our production capacity, reflects the increasing demand for Husco Products . . . A demand based on today's highest standards of engineering and performance.

Primarily Engineered for Construction and Materials Handling Equipment, HUSCO Hydraulic Units are preferred for Their Space-Saving, Positive Operational Control and Cost-Saving Efficiency.

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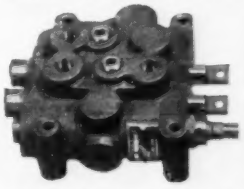

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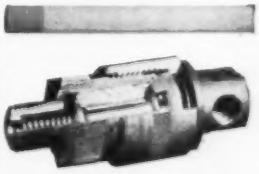
HUSCO ROTARY SWIVEL



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HYDRAULIC UNIT SPECIALTIES CO.

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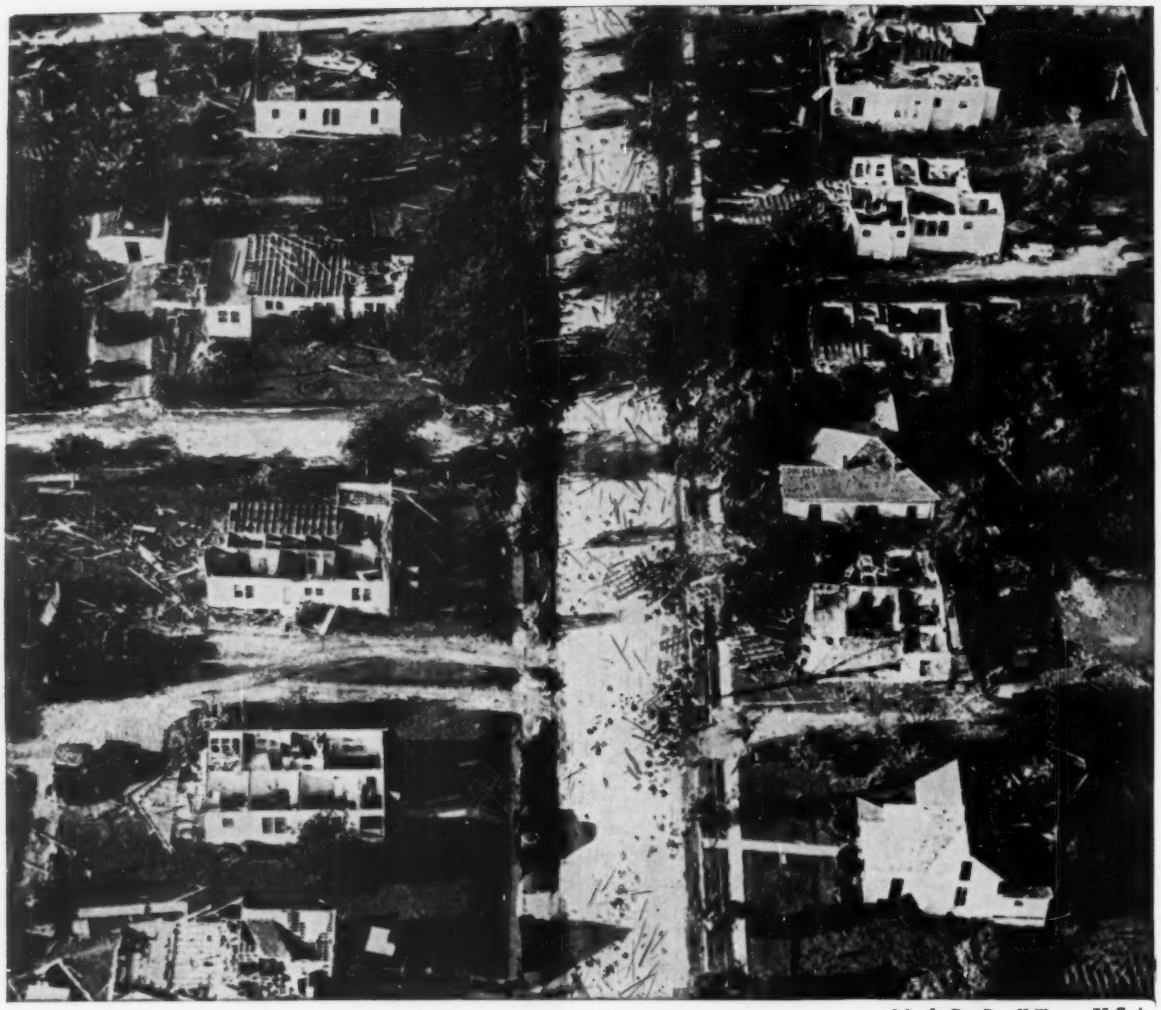

Maple St., Small Town, U.S.A.

A TOWN WHERE "NOTHING EVER HAPPENS"...

A home town—like your town. A place where people said "it couldn't happen to us."

But it *did*. Like a whip, a great tornado lashed down Maple Street, splintering houses, leaving people hurt—homeless—panic-stricken.

A desperate call went out for the Red Cross and quickly, automatically, the team went into action.

Red Cross nurses slipped into uniform . . . volunteers set up first aid stations . . . canteens fed the hungry. Later, Red Cross money and work helped rebuild the town.

Last year was one of the worst disaster years of this century, and the year before, 1956, was almost as bad. Every month and in every state, the Red Cross strained to the limit as hurricanes, floods, tornadoes, forest fires swept across the country.

Red Cross receives no government funds—depends entirely upon *you* for support. Give as much as you can. Your dollars may go to your own town when it needs them most.

Join and Serve

SPACE CONTRIBUTED BY MACHINE DESIGN

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DOES specialized BUSINESS PUBLICATION ADVERTISING HELP SALESMEN?

No one is in a better position to give a hard-boiled, practical answer to this question than the men who spend their working lives on the sales front... the men the ads are supposed to help... the men who sell.

Here is the statement of a salesman who knows what advertising does for him when it appears in the industrial, trade or professional publications that serve the specialized markets to which he sells:

says Mr. Hegarty:

Jack Hegarty
Texas Instruments
Incorporated
sells to industry

"I sell semiconductors and other components to original equipment manufacturers in the electronics field. With the tremendous expansion in the electronic industry today, one of our problems is prompt coverage of the market when a new or improved device is announced. I can contact all my larger accounts within a few days, but it takes considerable time to cover the many smaller accounts.

"That's one of the reasons I think our advertising in business publications is so important. It covers all my prospects, large and small, and gets the story of our products to all three groups that can influence purchases—the engineers, the purchasing agents and top management. In some accounts 50 or 60 engineers will attend a meeting. However, there are still many decision-making personnel who can't attend because of other demands on their time. But I know that they will get our story from our advertising.

"On cold calls, many times my selling effort is greatly assisted by the 'pre-selling' of our advertising and it seems to me that advertising often gets me an entree at a higher level than I can usually get on cold calls.

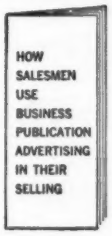
"It helps in other ways, too. For instance, we get inquiries for applications and devices that haven't been developed by our company. Prospects read the advertising, get clues, then contact us. In one case we ran an ad that basically showed a specification sheet on a new component. On one inquiry I followed up, the engineer had the magazine open on his desk right at our ad. He asked me, 'Can you meet this spec?' It was different—but, by some specialized design work, something we could do. I secured a first release order for over $70,000 just from this one inquiry.

"While my division of our corporation had first established its name in the industry on the basis of its work in semiconductors, we also manufacture many other components. They are in competition with units of companies longer established than we are. Here our advertising helps establish our name as a progressive company with a dependable reputation, good to deal with."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable, you can be sure that it is really helping them sell. If too many answers are negative, it could well pay you to review your advertising objectives — and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' business publication advertising.



You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy.

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NBP

...each of which serves a specialized market in a specific industry, trade or profession.

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Please send me a free copy of the NBP booklet "How Salesmen Use Business Publication Advertising in Their Selling."

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Company _____

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Assure your design of dependable, trouble-free power

UL and CSA approvals

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TIMING MOTORS

- *PRECISION MADE*
- *ACCURATE*
- *TESTED 51 TIMES*
- *BUILT FOR LONG LIFE BY HANSEN, RECOGNIZED QUALITY LEADER*

SYNCHRON synchronous motors operate smoothly, evenly in any position at temperatures from —40° to + 140° F., start instantly under load; pull up to 20 in. oz. at 1 R.P.M. Available in 42 speeds from 0.8 R.P.M. to 600 R.P.M.

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(20 IN. OZ.)

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(1 R.P.H.)

A new timing motor developed especially for slow motion jobs. Guaranteed 20 in. oz. at 1 r.p.h. (1/60 r.p.m.)

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synchronous motors, timing machines, clock movements, magnatorc DC motors

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Princeton 12, Indiana

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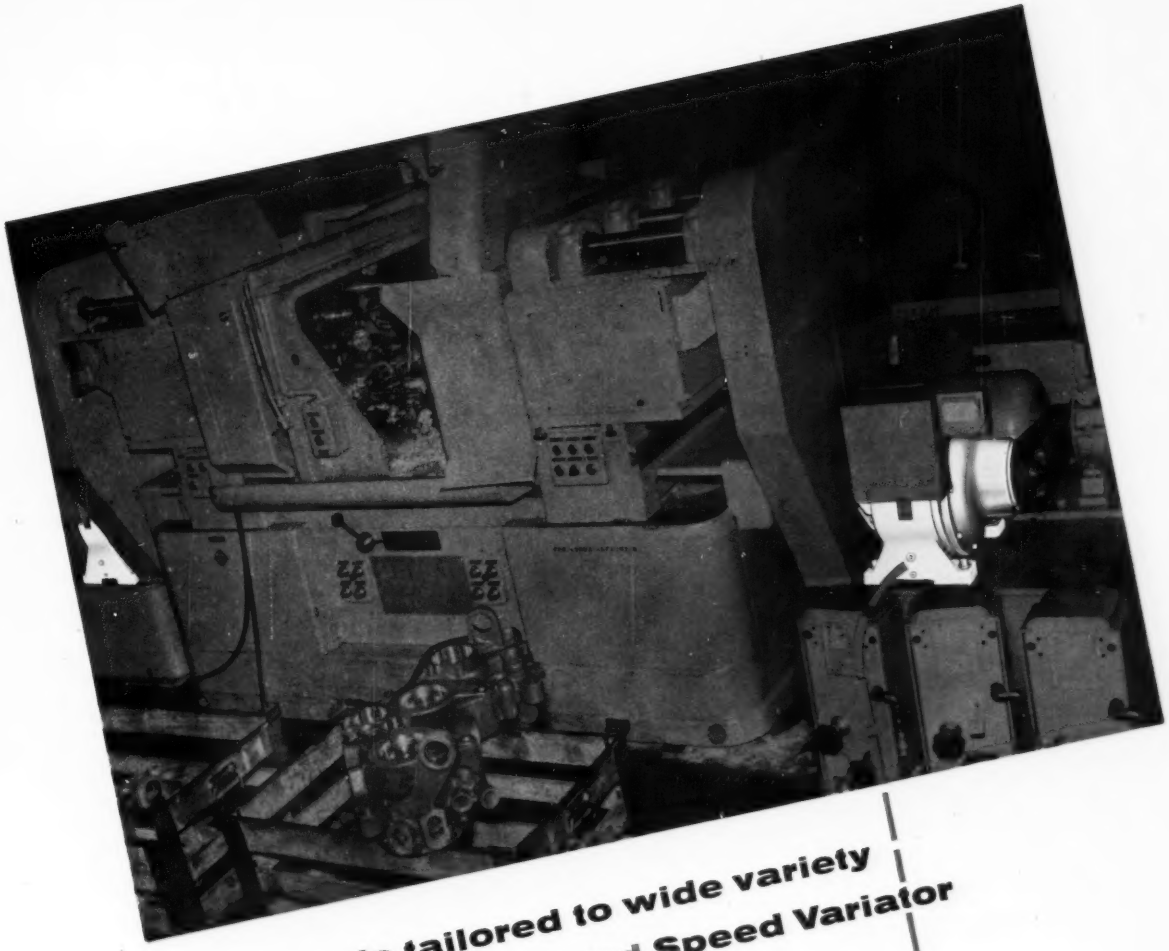

Machining speeds tailored to wide variety of metals with Cleveland Speed Variator

In the manufacture of aircraft engine components, Cleveland Speed Variators permit fast, accurate adjustment of machining speeds to the exact rpm required for various metals from magnesium to 38 Rc steel.

Infinitely variable, the Speed Variator provides continuous speed progressions over its full 9:1 range . . . from ⅓ to 3 times input speed. Manual or automatic remote control instantly and smoothly adjusts output speed. Variator is rugged, compact, quiet running.

For full details—photographs, sectional drawings, rating tables, specifications—write today for Bulletin K-200. The Cleveland Worm & Gear Company, Speed Variator Division, 3287 East 80th St., Cleveland 4, Ohio.

Sales representatives in all major industrial markets.
In Canada: Peacock Brothers Limited.

HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).

CLEVELAND SPEED VARIATOR

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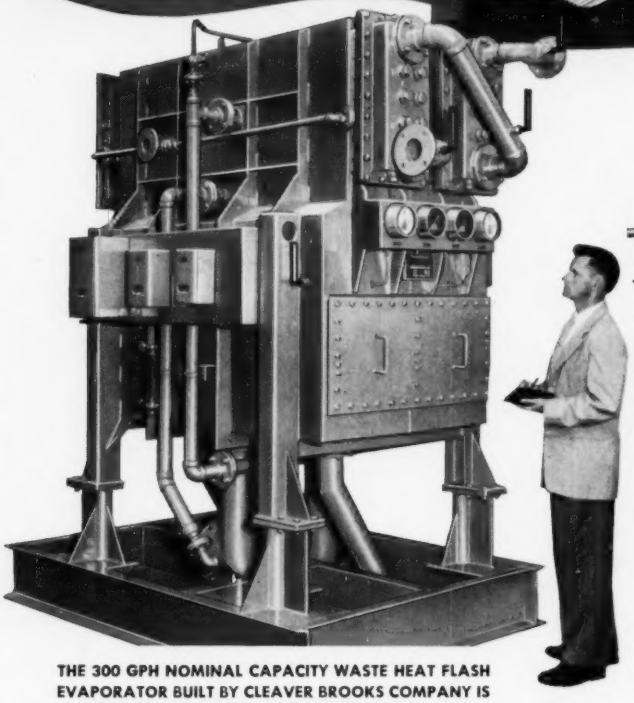
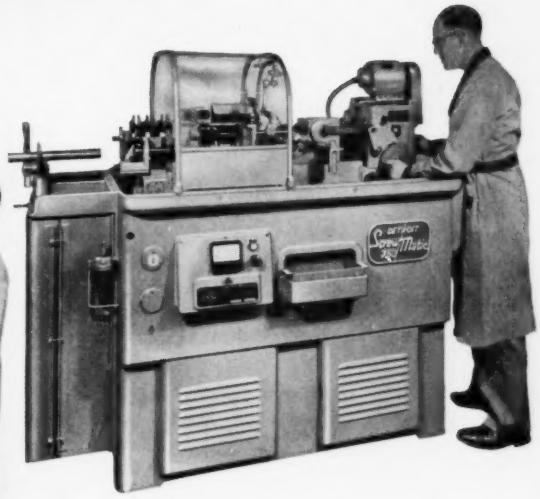
Choice of the Leaders

CUTLER-HAMMER
MOTOR CONTROL
C-H

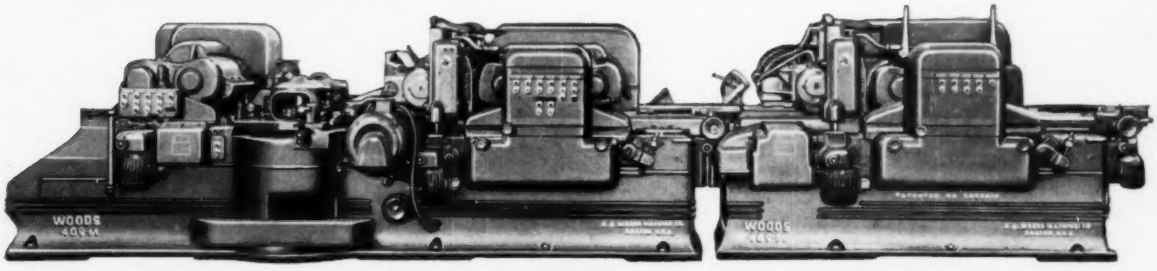
The Mark of Better Machines



THE 300 GPH NOMINAL CAPACITY WASTE HEAT FLASH EVAPORATOR BUILT BY CLEAVER BROOKS COMPANY IS EQUIPPED WITH CUTLER-HAMMER THREE-STAR MOTOR CONTROL AS ORIGINAL CONTROL EQUIPMENT.



THE DETROIT SCREWMATIC 750 MANUFACTURED BY THE GEAR GRINDING MACHINE COMPANY INCLUDES CUTLER-HAMMER THREE-STAR MOTOR CONTROL AS ORIGINAL FACTORY EQUIPMENT.



THE S. A. WOODS MACHINE COMPANY 409M STREAMLINED FAST FEED HEAVY DUTY PLANER AND MATCHER COUPLED WITH THEIR 469M HEAVY DUTY BLANKER IS EQUIPPED WITH CUTLER-HAMMER THREE-STAR MOTOR CONTROL AND OIL-TIGHT PUSHBUTTONS.

The Stars Lead the Way

Winning recognition as a leader in any industry is not an easy task, and holding this coveted position year after year is even more difficult. Leading machinery builders know this and safeguard their enviable position by a never-ending search for an improved product . . . new materials, new methods, new components. *The stars lead the way.*

In recent years, the broad swing to Cutler-Hammer Three-Star Motor Control and Heavy Duty Oil-Tight Pushbuttons by leading builders of all types of machines has been most significant. Such acceptance only comes through careful comparisons which prove a definite superiority. Cutler-Hammer Three-Star Motor Control installs easier, works better and lasts longer . . . *the stars lead the way.* Now more than ever before, Cutler-Hammer Motor Control is the choice of the leaders . . . the mark of better machines. CUTLER-HAMMER Inc., 1310 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

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